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NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

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MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
```

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)
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SHELTERS
  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Corporate Authors

Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN.  Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

Technical report literature is also indexed by report numbers. This index includes information on where individual reports may be obtained. While not reports, patents and conference papers are indexed here as a matter of convenience.

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TID-
  3311(Suppl. 2)  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                              1966)
  22298           21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                              1967)
  23267           21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                              1966)
  23287           21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420           21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474           21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478           21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482           21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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CHEMISTRY

Analytical Chemistry

Refer also to abstracts 213, 315, 462, 600, 1037, 1837, and 1969.

1 (CEA-R-3474) APPLICATION OF ANALYSIS BY SPECTROMETRY OF X-FLUORESCENCE RADIATION. DETERMINATION OF P-W-Zr IN PHOSPHOTUNGSTATE, ZIRCONIUM TUNGSTATE, ZIRCONIUM PHOSPHATE, THEIR MIXTURES, AND THEIR DEGRADATION PRODUCTS. Guillon, Andre; Lebrun, Michele (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1968. 39p. (In French). Dep.

By chemical methods it is possible to determine accurately the constituents of solid samples containing essentially P, Zr, and W. The use of the x-ray fluorescence technique for this determination is discussed. The process used is the borax-bead method. Fusion eliminates heterogeneity effects such as those due to the size, porosity, and composition of the grains. Interelement effects, however, are not suppressed. These effects were studied and corrections made for them. (auth)

2 (CISE-108) RADIOCHEMICAL STUDIES FOR RADIOACTIVITY DETERMINATIONS ON MARINE SEDIMENT SAMPLES: ^{90}Sr, ^{144}Ce, ^{147}Pm, AND ^{155}Eu. Albini, A.; Giacoletto, C.; Mezzadri, M. G.; Triulzi, C. (Centro Informazioni Studi Esperienze, Milan (Italy)). June 1968. 77p. Dep.

Particular attention is given to treatment the sediment undergoes from attack with HCl and H_2O_2 to preparation of sources for radiometric measurement. Information is then given for measurements of low radioactivity levels, separation chemical yields, reagent blanks, and for calculation of the radioactivity of the sources obtained. Results are reported, which were obtained by applying the whole procedure to sediment samples of the Ligurian Sea collected on February 4, 1966, and the radioactivity of ^{90}Sr, ^{144}Ce, ^{147}Pm, and ^{155}Eu is given as a function of sediment thickness. In appendixes additional techniques are examined, which were used to set up the operating procedure and a list of equipment and of reagents used in the course of the whole procedure is given. (auth)

3 (IN-1203) ANNUAL REPORT FOR THE ANALYTICAL CHEMISTRY BRANCH FOR PERIOD ENDING JUNE 30, 1968. (Idaho Nuclear Corp., Idaho Falls). Sept. 1968. Contract AT(10-1)-1230. 225p. Dep. CFSTI.

Research progress is reported in seven sections. A separate abstract was prepared for each section. (M.C.G.)

For abstracts of individual sections see: 4–10.

4 (IN-1203, pp 8-29) ANALYTICAL DEVELOPMENT. (Idaho Nuclear Corp., Idaho Falls).

Mathematical models were developed for electrochemical processes. A fissionable isotope monitor based on the delayed neutron technique for continuous analysis of chemical processing plant streams is described. Classical methods are given for determination of B, C, Cl^-, Cr, Co, Cu, metals, Ni, Ru, U, Zr, nitrates, nitrites, and Pb. Remotely operated facilities are described. (M.C.G.)

5 (IN-1203, pp 30-6) SPECTROSCOPY. (Idaho Nuclear Corp., Idaho Falls).

Research progress on mass spectroscopy is reported. Improvements in equipment and methods for spectrochemical analysis are considered. (M.C.G.)

6 (IN-1203, pp 37-51) CHEMICAL ANALYSIS. (Idaho Nuclear Corp., Idaho Falls).

Research progress is reported on radio, special, remote, and service analyses. Topics covered include: chemical processing plant analyses, health and safety studies, improvement in equipment, gamma spectra analysis, and method improvements. (M.C.G.)

7 (IN-1203, pp 52-61) STANDARDS AND QUALITY CONTROL. (Idaho Nuclear Corp., Idaho Falls).

Topics covered include: bias and precision data, standards and reagents, calibration of pipetting equipment, controls for low-level uranium analysis, and improvement in quartz water distillation apparatus. (M.C.G.)

8 (IN-1203, pp 62-6) UMPIRE QUALIFICATION PROGRAM. (Idaho Nuclear Corp., Idaho Falls).

Participation of AEC, U.S. commercial, and foreign laboratories in the umpire qualification program is discussed. Preparation and distribution of standards are described. (M.C.G.)

9 (IN-1203, pp 67-8) BURNUP DETERMINATION OF NUCLEAR FUELS. (Idaho Nuclear Corp., Idaho Falls).

Methods are being developed for accurate determination of burnup of nuclear fuels. Measurements are being made of the fission yields of selected nuclides for selected fissioning isotopes. (M.C.G.)

10 (IN-1203, pp 69-101) LOFT-ECCS SUPPORT PROGRAM. (Idaho Nuclear Corp., Idaho Falls).

Research progress is reported on sample processing and packaging, a particulate iodine sampling system, gas chromatography, and fission product analysis. Analytical service for the LOFT-ECCS chemical development program is described. (M.C.G.)

11 (KY-L-454(Rev.1)) ANALYTICAL PROCEDURES FOR URANIUM HEXAFLUORIDE SPECIFICATIONS. Levin, R. W.; Katzel, V. G. (Paducah Gaseous Diffusion Plant, Ky.). June 13, 1968. Contract W-7405-eng-26. 74p. Dep. CFSTI.

Analytical procedures used for specification analysis of UF_6 at the Paducah Plant Laboratory are compiled. (M.C.G.)

12 (LA-4007) X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF TANTALUM AND TUNGSTEN. Hakkila, E. A.; Deming, S. N.; Hurley, R. G. (Los Alamos Scientific Lab., N. Mex.). Sept. 16, 1968. Contract W-7405-eng-36. 9p. Dep. CFSTI.

Tantalum and tungsten, when present at concentrations between 5 and 95% in various materials, are measured by x-ray spectrometric methods. For analysis of binary mixtures, the sample is dissolved in a mixture of hydrofluoric and nitric acids, the solution is irradiated using a molybdenum-target x-ray tube, and the intensity of the $L\alpha_1$ x-ray for tantalum or tungsten is measured. The concentration of tungsten or tantalum is determined by comparing the x-ray intensity with intensities measured for solutions having known tungsten or tantalum concentrations. The relative standard deviations of the line intensity method are in the range between 2 and 1% for determining concentrations between 5 and 95% of tungsten or tantalum. An internal standard method is used for analysis of more complex mixtures; this method is applicable also to the analysis of binary mixtures. The sample is dissolved in hydrofluoric and nitric acids, an internal standard is added, and the solution is irradiated using a molybdenum-target x-ray tube. Zinc is added as an internal standard for the determination of tan-

talum or tantalum and tungsten, and copper is the internal standard for the determination of tungsten only. The ratios of the intensities of the $L\alpha_1$ x-ray for tantalum and tungsten to the $K\alpha$ x-ray for zinc, or of the $L\alpha_1$ x-ray for tungsten to the $K\alpha$ x-ray for copper, are determined. Concentrations of tantalum and tungsten are obtained by comparing the intensity ratios with equivalent ratios determined for solutions having known tantalum, tungsten, zinc, and copper concentrations. The relative standard deviations using the internal standard method are in the range between 1 and 0.6% for determining 5 to 95% of tantalum and between 2.9 and 0.4% for determining 5 to 95% of tungsten. Serious interference is caused by copper, nickel, rhenium, hafnium, iridium, or platinum in the determination of tantalum, and by nickel, hafnium, rhenium, iridium, or platinum in the determination of tungsten. (auth)

13 (MLM–1515) STATISTICAL EVALUATION OF SELECTED ANALYTICAL PROCEDURES. Bohl, D. R.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). Sept. 24, 1968. Contract AT-33-1-GEN-53. 14p. Dep. CFSTI.

A data evaluation study was conducted to evaluate the precision and accuracy of analytical procedures. Conventional statistical formulas were used to evaluate the data. The procedures evaluated statistically were: a potentiometric method for determining iron and uranium, a volumetric titration of nickel, and the determination of uranium by controlled-potential coulometric and potentiometric titration. The accuracy, standard deviation, and confidence intervals were calculated using historical data from these procedures. (auth)

14 (MLM–1544) SPECTROPHOTOMETRIC DETERMINATION OF FLUORIDE IN PLUTONIUM WITH ZIRCONIUM–ERIOCHROME CYANINE R. Redding, P. L.; Bishop, C. T.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). Sept. 24, 1968. Contract AT(33-1)-Gen-53. 10p. Dep. CFSTI.

A simple and rapid spectrophotometric method for the determination of 10 to 70 μg fluoride in up to 10 mg plutonium was developed. The interference from plutonium in the determination of fluoride by zirconium–Eriochrome Cyanine R was eliminated by reduction of the plutonium to the tripositive oxidation state with mercaptoacetic acid. The sulfate ion interferes, but relatively large amounts of iron(II), nickel, and cobalt can be tolerated. (auth)

15 (NP–17579, pp V.1-2) ANALYSES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

A development program was initiated for accurate determination of carbon and the sensitive detection of oxygen and nitrogen. A study was begun on the polarographic behavior of plutonium and on uranium determination in the presence of plutonium. In-line process control equipment is being developed for fluoride volatility fuel reprocessing. Methods were developed for the determination of plutonium, including a nondestructive method utilizing neutron counting. Analyses carried out are listed. (M.C.G.)

16 (PG-Report–845) ANALYTICAL METHOD FOR THE DETERMINATION OF ^{106}Ru, ^{103}Ru, ^{95}Zr, ^{95}Nb, ^{144}Ce, AND ^{137}Cs IN PLUTONIUM DIOXIDE. (United Kingdom Atomic Energy Authority, Sellafield (England). Product Group). 1968. 6p. Dep. CFSTI. UK.

A solution of PuO_2 in $HF-HNO_3$ containing 200 to 300 mg/ml Pu was scanned using a Li-drifted germanium detector and a 400-channel spectrum analyzer. The disintegration rates of the six isotopes were determined by a photopeak integration technique. (auth) (UK)

17 (RLO–2046-1) DETERMINATION OF TOTAL BODY CALCIUM (SKELETAL MASS) IN MAN BY IN VIVO NEUTRON ACTIVATION ANALYSIS AND TOTAL BODY COUNTING. Project Progress Report. Nelp, Wil B. (Washington Univ., Seattle. School of Medicine. Veterans Administration Hospital, Seattle, Wash. Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1, 1968. Contract AT(45-1)-2046. 21p. Dep. CFSTI.

The progress made during the first nine months of the project funding, was in a more detailed and comprehensive understanding of the distribution of neutron thermal effect within human cadavers, in perfecting the techniques to achieve optimum uniformity of irradiation, and in making final modifications on the whole-body counting assembly. The possible usefulness of the detection of whole-body phosphorous or localized bone phosphorous with 14 MeV neutron irradiation was initially evaluated. (auth)

18 (WAPD–321) SEMIQUANTITATIVE ANALYSIS OF UNKNOWN SAMPLES BY X-RAY FLUORESCENCE SPECTROGRAPHY. Anater, T. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1968. Contract AT(11-1)-Gen-14. 26p. Dep. CFSTI.

A method is presented for x-ray spectrographic, semiquantitative analysis of unknown samples for 27 elements commonly encountered at Bettis Atomic Power Laboratory. The method uses normalization factors, which render the major elemental peaks proportional in height to the weight concentration of the elements in the sample. This method is unique in that it requires no standards or standard curves, and any combination of the 27 elements at any detectable concentrations can be determined irrespective of sample form or geometry. This procedure is nondestructive in the special sense that it does not require alteration of the sample in any way even before analysis. A factor of two is claimed for the accuracy of the method, although the great majority of the data are within ±20% (relative). Elements below atomic number 13 (Al) cannot be detected. Physical size is the only other limiting aspect. (auth)

19 INVESTIGATION OF TRACE ELEMENT DISTRIBUTION IN POTSHERDS BY ACTIVATION ANALYSIS. Rao, N. Jagannadha; Iyer, R. Krishnamoorthy; Das, M. Sankar (Bhabha Atomic Research Centre, Trombay). pp 498-504 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The possibility of using neutron activation as a method of studying the trace element distribution in archaeological specimens (potsherds) was investigated. Sodium, manganese, lanthanum, scandium, and chromium were identified in the samples through their radioisotopes and the relative distribution of activity measured. Results are reported for specimens belonging to two groups to indicate the degree of correlation between them. (auth)

20 DETERMINATION OF TRACE CONSTITUENTS IN ALLOY STEELS BY NEUTRON ACTIVATION ANALYSIS. PART II. DETERMINATION OF MOLYBDENUM. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). pp 505-11 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Molybdenum was determined in steel by neutron activation followed by rapid radiochemical separation and gamma spectrometric measurements. The main steps of chemical separation are dissolution of the irradiated steel in the presence of carrier, extraction of molybdenum and iron with ethyl ether, backextraction into the aqueous phase, precipitation and extraction of Mo-α-benzoinoxime with chloroform, re-extraction into alkali solution, decomposition of oxime with perchloric acid and final precipitation of molybdenum with 8-hydroxyquinoline. The separation procedure takes about 45 minutes and a chemical yield of 60% is obtained. The precision and accuracy of the method are ±5 and ±8%, respectively; the sensitivity is 0.21 μg of molybdenum. (auth)

21 NEUTRON ACTIVATION ANALYSIS OF RHENIUM IN COPPER ORES. Doctor, Z. K.; Haldar, B. C. (Inst. of Science, Bombay). pp 512-18 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A method is described for the determination of rhenium in copper ores by neutron activation analysis. It consists of irradiation of samples for 24 hours in a high thermal neutron flux, separation of radiochemically pure rhenium from large quantities of other activities and measurement of the 0.137-MeV gamma ray of 90-hour ^{186}Re. The separation procedure involves fusion of the irradiated ore and fifteen milligrams of potassium perrhenate with sodium peroxide, treatment of the fused mass with water, extraction of rhenium(VII) into pyridine, sulfide precipitation, and a final precipitation of rhenium(VII) as nitron perrhenate. The separation and measurements are completed within 40 minutes after receipt of the irradiated material in the laboratory. One μg of rhenium can be determined with a precision of 6%. (auth)

22 RADIOCHEMICAL PURITY OF SOME RADIOPHARMACEUTICALS. Gopal, N. G. S.; Cherian, S.; Patel, K. M.; Thakur, M. L. (Bhabha Atomic Research Centre, Trombay, India). pp 271-9 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Radiochemical purity, which is a term not synonymous with chemical purity and radioactive purity, but means the absence of other chemical forms of the radioelement than that stated, is a particularly important criterion for radioisotopes and their labeled compounds. Different chemical forms can be expected to appear during processing and also as a result of storage. Hence it is necessary to determine the extent of occurrence of these different species, which is examined by suitable techniques among which paper chromatography, paper electrophoresis, and ion ex-

change chromatography stand out in their versatility. Some methods, developed for the control of radiochemical purity of some radiopharmaceuticals in current use, were studied. Triolein and oleic acid labeled with ^{131}I are controlled by paper chromatography in aliphatic alcohols (C_3 to C_5) or by paper electrophoresis in phosphate buffer. A number of other radioiodine labeled compounds are controlled by the latter technique. The percentage of ^{51}Cr activity associated with ^{51}Cr-serum albumin labeled with $^{51}Cr(III)$ is determined by paper electrophoresis in barbitone buffer. Free ^{58}Co present in ^{58}Co vitamin B_{12} is controlled by paper electrophoresis in dilute sodium chloride (pH 4). (auth)

23 DETERMINATION OF RUTHENIUM ACTIVITY IN AGED FISSION PRODUCT SOLUTION. Chitnis, R. T.; Chitale, S. G. (Bhabha Atomic Research Centre, Trombay, India). pp 205-10 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A method was developed for the determination of ruthenium activity in the process streams from "Purex Process." The solutions encountered here are sufficiently cooled so that a few fission product activities remain in the solution. The fission products met within such solutions are mostly $^{144}Ce-^{144}Pr$, $^{106}Ru-^{106}Rh$, ^{137}Cs, $^{95}Zr-^{95}Nb$, and $^{90}Sr-^{90}Y$. In this method ^{106}Ru (along with the carrier) is first oxidized with potassium periodate in alkaline medium in order to effect proper isotopic exchange between the carrier and the active ruthenium. It is then reduced to ruthenium(IV) by ethyl alcohol and precipitated as hydrous oxide, $RuO(OH)_2$. The oxide is dissolved in HCl, acidity adjusted to about 3N and Ru is then extracted with a 20% solution of tri-iso-octylamine in xylene. Ruthenium is stripped from the organic phase by 10N HNO_3 and precipitated by alkali. The precipitate is dissolved in HCl and Ru is finally reduced to metal, mounted and counted for beta activity according to the usual procedure. The results are comparable with the distillation method. The yield is about 70%. (auth)

24 A COMBUSTION METHOD WITH A RADIOMETRIC FINISH FOR THE DETERMINATION OF MICROGRAM AMOUNTS OF SULPHUR IN LIGHT PETROLEUM. Goode, E. V. (District Coll. of Tech., Derby, Eng.). Analyst, 93: 663-8(Oct. 1968).

A radiochemical technique was combined with a modification of the surface combustion method of Schoeberl to give a rapid method for the determination of sulfur in the range 1 to 10 ppM in organic substances such as purified light petroleum. The sulfate formed is precipitated with barium chloride labeled with barium-133, and the amount of barium sulfate determined by measuring its activity. A radiometric finish has the advantage of potential sensitivity, and barium-133 can be obtained with a specific activity of 1 Ci per g. Thus, a scintillation counter with an efficiency of 30% and a background of 20 counts per second (shielded) can detect 0.4×10^{-3} μg of sulfur, as barium sulfate, assuming no solubility losses. The lowest detectable concentration of sulfur is dependent on the magnitude of the blank value, but because sulfate appears to be an almost universal contaminant it was found, under normal laboratory conditions, that it was impossible to reduce the blank value to much below the equivalent of 1 ppM in the sample. (auth) (UK)

25 USES OF ION EXCHANGE RESINS IN SUBSTOICHIOMETRY. Briscoe, G. B.; Dodson, A. (Univ. of Aston, Birmingham, Eng.). Proc. Soc. Anal. Chem., 5: 202-3(Oct. 1968).

Substoichiometry is a recently proposed technique of considerable value in trace metal analysis. By its use radioisotope dilution analysis can be simplified and improved in sensitivity and selectivity. The use of ion exchange resins has been suggested for the substoichiometric step where solvent extraction cannot be used. EDTA is usually recommended as a complexing agent since its complexes are strong and, being negatively charged, are not exchanged on to cationic resins. In rare earth analysis, however, difficulty has been experienced with EDTA and common cationic resins such as Dowex 50 × 8 or Amberlite IR 120; these difficulties are outlined and means suggested to overcome them. (UK)

26 COPRECIPITATION AND THE SPECTROPHOTOMETRIC DETERMINATION OF URANIUM AS DIBENZOYLMETHANE CHELATE. Shigematsu, Tsunenobu; Tabushi, Masayuki; Matsui, Masakazu; Munakata, Megumu (Kyoto Univ.). Bull. Chem. Soc. Jap., 41: 1610-14(July 1968).

The coprecipitation and direct photometric method was applied to the uranium β-diketonate system. Uranyl ion was coprecipitated as dibenzoylmethanate with o-phenylphenol and determined spectrophotometrically after the precipitate was dissolved in butyl acetate. The effect of ligand concentration on the per cent coprecipitation-pH curve was studied and the curve was not affected by the ligand concentration in the range from 2×10^{-2} to 4×10^{-4}M. Over the 200 mg of o-phenylphenol, an almost quantitative coprecipitation was obtained, though the absorbance slightly decreased with the increase in the coprecipitant amount (about 2% per lg o-phenylphenol). As many diverse ions interfered with the determination of uranium, the solution of calcium–EDTA chelate was used as a masking agent. When a small amount of alkylamine was added, the recovery of uranium became more complete. The effect of alkylamine was probably caused by the adduct formation of uranium chelate with alkylamine. (auth)

27 CONTRIBUTION TO THE DETERMINATION OF ^{210}Po IN RADIOACTIVE EFFLUENTS. Zange, E. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 407-9(Sept.-Oct. 1968). (In German).

When the unfiltered sample of the effluent is concentrated by evaporation and oxidized the ^{210}Po is separated from the dry residue by sublimation under normal pressure in a simple device. Finally the ^{210}Po is plated by spontaneous deposition on a silver foil. The activity is measured in a proportional counter. The average total yield amounts to 89.9%, and the standard deviation for a single determination was calculated to be ±8.9%. (auth)

28 AMPEROMETRIC DETERMINATION OF CERIUM AND VANADIUM, AND CERIUM AND MOLYBDENUM IN THEIR BINARY MIXTURES USING TWO INDICATOR ELECTRODES. Singh, D.; Bhatnagar, Uma (Banaras Hindu Univ., India). Israel J. Chem., 5: 29-32(Jan. 1967).

The amperometric method was extended for estimation of mixtures of Ce and V or Ce and Mo, using ascorbic acid as the titration reagent. In successive determination of Ce and V, Ce(IV) should titrate before V(V). Nevertheless, early appearance of V(IV) indicates that V(V) is reduced before the reduction of Ce is completed. Titration results are satisfactory if the acid concentration exceeds 2.0N. In a test solution containing Ce(IV) and V(V), best results for amperometric titration of Ce were obtained with 3.5N H_2SO_4 and at an applied potential of 200 mV. When reaction with Ce was complete, concentrated NH_4OH was added dropwise to pH 1.0, and the applied potential was altered to 100 mV. Titration was then continued until the indicator current for reduction of V dropped to a constant value. Ascorbic acid reacts with Mo(VI) in slightly acidic or neutral medium only. Therefore, here again the successive determination of Ce(IV) and Mo(VI) with ascorbic acid required only the maintenance of appropriate acidity. In 5.0N H_2SO_4 medium, Ce behaves reversibly and is titrated as described previously. After the completion of the reduction of Ce(IV) in the presence of Mo(VI), 6.0N NH_4OH was added dropwise nearly to neutrality. The pH was then adjusted to 5.2 to 6.2 by acetate buffer, potential altered from 200 to 100 mV, and the titration continued until the galvanometer deflections approached a constant value. (BBB)

29 INVESTIGATIONS ON THE PHOTOMETRIC DETERMINATION OF TANTALUM WITH PYROGALLOL. Sarry, Brigitte; Lange, Arno (Technische Univ., Berlin). Z. Anal. Chem., 241: 186-96(Sept. 27, 1968). (In German).

Optimum conditions for the photometric determination of tantalum with pyrogallol in sulfuric acid solutions at 405 nm have been elaborated. The method has been checked statistically. (auth)

30 A METHOD FOR DIRECT OXYGEN DETERMINATION IN MOLTEN METALS. Pargeter, J. K. (International Nickel Co., Inc., Suffern, N. Y.). J. Metals, 20: No. 10, 27-31(Oct. 1968).

The basis of the method described for the very rapid determination of oxygen in liquid metal is the potential developed between an air/zirconium oxide electrode and the liquid metal. The quantitative evaluation of the conduction properties of stabilized zirconia at temperatures and oxygen partial-pressure ranges of interest in steel making is involved. The results showed excellent consistency of results from probe to probe under conditions when major variations in oxygen content would not have been expected. There was also a general tendency for the oxygen contents of the melts tested to rise slightly during the test period. (P.C.H.)

31 APPLICATION OF THIOLACTIC [2-MERCAPTOPROPIONIC] ACID AND OF ITS p-PHENETIDIDE, TO THE GRAVIMETRIC DETERMINATION OF ZIRCONIUM. Nacu, A.; Mocanu, R. (Univ. Al. I. Cuza, Iasi). An. Stiint. Univ. Al. I. Cuza, Iasi, Sect. I, 13: 41-4(1967). (In Rumanian).

Zirconium is quantitatively precipitated by aqueous 2-mercaptopropionic acid but not by its p-phenetidide at pH 3.7 to 4.5. The sample solution is diluted to 100 to 120 ml, 10 to 15 ml of a 5% aqueous solution of the reagent are added, and the pH is adjusted to 4.5 with an acetate buffer. The solution is heated for 10 to 15 min, and then after about 1 hr the precipitate is collected, washed with 5% aqueous NH_4OH, calcined, and weighed as ZrO_2. Results for the determination of 14 to 345 mg of Zr agreed well with those

obtained with mercaptoacetic or m-nitrobenzoic acid. Mg, Be, Al Ce(IV), rare earth metals, Cr(III), Fe(III), V(IV), U(VI) do not interfere with the determination, but Sn(II), Hg(II), Zn, Cd, Ti(IV), Th, Cu(II), Pb(II), Ni(II), and Co(II) all form colored precipitates. (TSS)

32 INVESTIGATIONS ON THE PHOTOMETRIC DETERMINATION OF MOLYBDENUM WITH PYRIDINE DERIVATIVES. Hartkamp, Heinrich. Z. Anal. Chem., 241: 66-80(1968). (In German).

Molybdenum in lower oxidation states reacted with several chelate-forming pyridine derivatives to give soluble complex compounds, the intense and characteristic light absorption of which were used for the quantitative photometric determination of small amounts of molybdenum. (auth)

33 NOTE ON THE ALKALI NITRATE FUSION FOR QUANTITATIVE ESTIMATION OF RUTHENIUM. Biswas, S. R.; Mukerji, J. (Central Glass and Ceramic Research Inst., Calcutta). Indian J. Chem., 6: 51-2(Jan. 1968).

The conditions for alkali nitrate fusion of ruthenium and its compounds, a procedure employed in the estimation of Ru, were worked out. Reproducible and satisfactory results were obtained when fusion was carried out at 350° for 4 hr. (auth)

34 CARRIER DISTILLATION METHOD FOR THE DETERMINATION OF IMPURITIES IN NIOBIUM OXIDE. Laib, R. D.; Lykins, J. D. (U. S. Industrial Chemical Co., Cincinnati). Appl. Spectrosc., 22: 539-41(Sept.-Oct. 1968).

A carrier distillation technique is described for the analysis of trace impurities in niobium oxide. The carrier used is a 1:1 mixture of AgCl and AgF. Separation of the carrier and sample charge along with the use of a boiler cap on the electrode cup greatly reduces the background and yet allows the impurities to be distilled into the arc within 90 sec. Sensitivity and precision data are included for 13 impurity elements. (auth)

35 X-RAY FLUORESCENCE ANALYSIS OF INDIVIDUAL RARE EARTHS IN COMPLEX MINERALS. Rose, Harry J. Jr.; Cuttitta, Frank (U. S. Geological Survey, Washington, D. C.). Appl. Spectrosc., 22: 426-30(Sept.-Oct. 1968).

A combined chemical x-ray fluorescence method is described for determining rare earth elements in small amounts of complex rare earth minerals. These elements yield a complex x-ray spectrum in which many of the analytical emission L_α lines of a given element coincide with the L_β and/or L_γ lines of a lighter rare earth element several atomic numbers removed. The proposed analytical scheme corrects for these interferences. Sixteen elements consisting of the lanthanides, yttrium, and scandium can be determined on as little as a 1-mg portion of the separated oxides. The oxides are dissolved in 1 ml of dilute acid, absorbed onto cellulose powder and pressed into a pellet for x-ray excitation. Chemically analyzed geologic standards are not required for calibration. (auth)

36 X-RAY FLUORESCENCE SPECTROMETRIC DETERMINATION OF RARE EARTHS IN PLUTONIUM. Hakkila, E. A.; Hurley, R. G.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). Appl. Spectrosc., 22: 434-7(Sept.-Oct. 1968).

Two methods were evaluated for determining rare earths in plutonium: (1) For the lighter rare earths ($Z \leq 66$), or low concentrations of the heavier rare earths, an adjacent rare earth was added as a carrier and also as an internal standard, the rare earths were separated from plutonium by fluoride precipitation, and the measured intensity ratios for the sample and for solutions having known concentrations were compared. The $L\beta_1$ x-rays were measured for the lighter rare earths and the $L\alpha_1$ x rays for the remaining lanthanides. (2) For the heavier rare earths ($Z > 66$), the $L\alpha_1$ x-ray intensities were measured from a nitric acid solution of the sample and compared to intensities obtained for solutions having known concentrations. The minimum concentrations that could be measured with a relative standard deviation no greater than 4% by the separation internal standard method varied from approximately 0.5% for lanthanum to 0.01% for lutetium. The direct measurement of x-ray intensity was much less sensitive. Applicability of the methods was shown by successful analyses of plutonium alloys containing dysprosium, thulium, or lutetium. (auth)

37 RARE-EARTH ANALYSIS BY A ROTATING PLATFORM, SILVER-SPARK TECHNIQUE. Lyon, Theodore R. (Phillips Petroleum Co., Idaho Falls, Idaho). Appl. Spectrosc., 22: 558-61(Sept.-Oct. 1968).

A rotating platform, silver-spark technique was adapted for analysis of rare earth elements directly, either as solutions or after coprecipitation with a carrier. The platform sample electrode is compared with the rod sample electrode conventionally used, and silver is shown to provide some advantages over copper as an electrode material. Observations are reported on conditions pertaining to the preparation and excitation of samples. Three varied applications of the method are briefly described, and matrix effects are discussed. Platform electrodes are found to be more convenient and adaptable than conventional rods, and the sensitivity of the method is comparable to the copper-spark method for small samples. When larger samples are used, the sensitivity decreases; however, good sensitivity can be obtained by properly selecting conditions or equipment. (auth)

38 USE OF EMISSION MOLECULAR BAND SPECTRA FOR ISOTOPIC ANALYSIS. Chaney, C. L. (Gulf General Atomic Inc., San Diego, Calif.). Appl. Spectrosc., 22: 584-6 (Sept.-Oct. 1968).

The emission molecular band spectra was used to determine the relative amounts of ^{10}B and ^{11}B in BO. An intensity integration process was used, in which the intensity of the band spectra per se was integrated over a region that was free of interference from unwanted spectral lines. One problem encountered was finding ways to produce the desired molecular band spectra. Exciting the oxide of the metals in a direct current arc in air did not generally give sufficient light intensity for recording on SA-1 spectrographic photographic plates; however, arcing the metal did. To increase the intensity further, the preferred excitation region in the arc-flame should be found. In the boron example, the preferred region was found at the interface of the blue and green regions of the arc. However, this region was not stationary in space long enough to yield analytical results with a precision of better than ±6%. (D.H.M.)

39 ISOTOPE ANALYSIS OF SEAWATER BY MASS SPECTROMETRY. Chow, Tsaihwa J. (Scripps Inst. of Oceanography, La Jolla, Calif.). J. Water Pollut. Contr. Fed., 40: 399-411(Mar. 1968).

The construction of a mass spectrometer for isotope analysis is described. Principles of the isotope dilution method are developed. A table enumerates elements that can be studied by the technique as a result of the efforts of the Oak Ridge National Laboratory in providing stable tracers of many (66) elements. Ten major and 35 minor constituents of seawater consist of unique isotope pairs, where long-lived radioactive nuclides are regarded as stable ions for mass spectrometric studies. There are 13 minor elements in seawater with suitable isotope pairs. Isotope dilution can be used for 8 dissolved gases in seawater. There are 17 stable elements that are monoisotopic or have radioactive nuclides too hot to be used as tracers. Therefore, these elements cannot be determined by this technique. Sampling, spiking, chemical separation, and purification procedures are reviewed. Contamination and isobar problems are noted. As an example, Pb isotopes varying from source to source as a result of the history of radioactive decay of minerals, and of industrial contamination, are determined for the oceans and major waterways of the world. (BBB)

40 MASS SPECTROMETRIC ISOTOPIC ANALYSIS OF CHLORINE BY THE SURFACE-IONIZATION METHOD. Zmbov, K. F. (Boris Kidrich Inst. of Nuclear Sciences, Belgrade). Appl. Spectrosc., 22: 576-8(Sept.-Oct. 1968).

A study of the surface ionization of barium chloride on a heated tungsten surface was made in order to evaluate the optimum conditions for obtaining intense and stable ion beams for use in isotopic analysis of chlorine. The ionization curves of Ba^+ and $BaCl^+$ ions show that $BaCl^+$ ions appear at relatively low temperatures of about 1000°K, rise with increasing temperature reaching a maximum at 1500°K, and then decrease slowly. The Ba^+ curve had a similar shape beginning at 1400°K and with a maximum at 2300°K. Results of the temperature-dependence studies indicated that the most convenient conditions for ionization of $BaCl_2$ are near 1500°K, and these were used for isotopic analysis. The isotopic ratio of $^{35}Cl/^{37}Cl$ in natural $BaCl_2$ was found to be 3.095 ± 0.006. The error attached to the mean value was calculated as the standard deviation of 10 measurements. The isotopic ratio is in good agreement with earlier measurements. (D.H.M.)

41 DETERMINATION OF GLUCOSAMINE AND GALACTOSAMINE IN SOME GLYCOPROTEINS BY RADIOISOTOPE DILUTION. Graham, E. R. B.; Neuberger, A. (St. Mary's Hospital Medical School, London). Biochem. J., 109: 645-50 (Oct. 1968).

The principle of radioisotope dilution was applied on a semimicro scale to the determination of glucosamine and galactosamine in some glycoproteins, such as immunoglobulins, a urinary glycoprotein, and blood-group-specific substances. The glycoprotein was hydrolysed in the presence of ^{14}C-labeled glucosamine or galactosamine or both. The amino sugars were made to react with naphthyl isothiocyanate and the products formed were isolated by a previously reported method. The specific radioactivities deter-

mined from liquid-scintillation counting and the extinction at 240mμ or 222mμ were used to calculate the content of amino sugars in the protein analyzed. Where the values could be compared with those found by other workers, differences were in general not very great. The advantages of the method are that high concentrations of acid can be employed and undesirable side reactions, which may occur with the free sugars, do not affect the results. A potential source of error of the method is discussed. (auth) (UK)

42 DETERMINATION OF $^{235}U/^{238}U$ RATIOS BY ACTIVATION ANALYSIS UTILIZING HIGH RESOLUTION γ-SPECTROMETRY. De Wet, W. J.; Turkstra, J. (National Nuclear Research Centre, Pretoria). J. Radioanal. Chem., 1: 379-87(Sept. 1968).

Application of high-resolution γ spectrometry to the direct determination of $^{235}U/^{238}U$ isotopic ratios in small uranium samples after neutron activation is reported. The consistency obtained relative to mass spectrometrically determined isotopic ratios is better than 5% for isotopic ratios between 0.06885 and 1.095. The method is not subject to the main disadvantages of the known radiochemical methods for $^{235}U/^{238}U$ isotopic ratio determinations, and should be appreciably more rapid compared to the solid-source mass spectrometric method giving the same precision. (auth)

43 DETERMINATION OF ^{210}Po IN LEAD. De Boeck, R.; Adams, F.; Hoste, J. (Ghent Univ.). J. Radioanal. Chem., 1: 397-412(Sept. 1968).

A quantitative separation procedure for ^{210}Po in lead was developed by cupferron and dithizone extraction. The ^{210}Po activity is plated on a silver foil for counting with a ZnS(Ag) scintillator, or by α-spectrometry with a surface barrier semiconductor. Different lead samples were analyzed ranging from very old lead with a negligible ^{210}Po content to recently manufactured lead samples showing up to 9100 disintegrations per hour and per gram of lead. The reproducibility and the accuracy of the analyses are satisfactory. (auth)

44 SENSITIVITY OF COMPLEX RADIOANALYTICAL METHODS. Lubecki, A. (Inst. of Nuclear Techniques, Krakow). J. Radioanal. Chem., 1: 413-17(Sept. 1968).

Introduction of the concept of "generalized sensitivity" enables several composite analytical radiometric methods to be compared. The concept of generalized sensitivity makes calculations of the relative error easier, when curvilinear nomographs are used for interpretation of the results. (auth)

45 QUANTITATIVE INVESTIGATION OF A FALLOUT SAMPLE FROM THE CHINESE NUCLEAR WEAPON TEST ON 12/28/1966. Allkofer, O. C.; Hauser, H.; Meyerbroeker, H.; Simon, M.; Woehren, C. (Univ., Kiel). Z. Naturforsch., 23a: 1272-6(Sept. 1968). (In German).

A quantitative total analysis of β- and γ-emitting radionuclides of a representative radioactive fallout sample from the Chinese nuclear test of Dec. 28, 1966, is presented. The different methods used to identify the fission products and induced radionuclides such as ^{237}U and ^{239}Np are described. Measurements of the concentrations of the fission products and of the induced radionuclides ^{237}U and ^{239}Np make it probable that the Chinese nuclear test of Dec. 28, 1966, was a fusion bomb with added fission of ^{238}U. (auth)

46 DETERMINATION OF RADIOCERIUM IN FISSION PRODUCTS BY EXTRACTION CHROMATOGRAPHY USING DI-(2-ETHYLHEXYL)PHOSPHORIC ACID. Krtil, J.; Bezdek, M.; Mencl, J. (Nuclear Research Inst., Rez, Czech.). J. Radioanal. Chem., 1: 369-78(Sept. 1968).

An extraction chromatographic method is described for determination of cerium in a fission product mixture. Cerium(IV) is separated on a column of siliconized kieselguhr saturated with bis-(2-ethylhexyl)ester of phosphoric acid (HDEHPA). After washing the column with a mixture of sodium bromate and nitric acid, cerium is eluted by a mixture of 5M HNO_3 and 0.1M ascorbic acid. Optimum conditions for the quantitative sorption and elution of cerium were found, and reproducibility of the yield was verified. The influence of other fission and corrosion products (Mg, Fe, Al, U) on the sorption and elution of cerium was studied. The method was successfully applied for determination of cerium in artificial and natural mixtures of fission products.

47 ASSAYS OF RADIOACTIVE MATERIALS FOR USE IN PATIENTS: A FIVE YEAR STUDY. Cliggett, Patricia A.; Brown, Joseph M. Jr. (National Institutes of Health, Bethesda, Md.). J. Nucl. Med., 9: 236-40(June 1968).

Counting systems used for the radiometric analysis of radioisotope-labeled pharmaceuticals are described. The counting systems include a quartz-fiber electroscope used to assay high-activity shipments and therapeutic doses of γ-emitting radionuclides; multichannel γ spectrometers for the assay of smaller quantities of γ-emitting radionuclides; and a liquid scintillation counting system for the assay of pure β-emitting radionuclides. Problems encountered for five years, during which time more than 12,000 assays were performed on materials labeled with one of 36 radionuclides, are summarized. The possibility of errors by commercial suppliers of radioisotope-labeled pharmaceuticals are discussed. (C.H.)

48 ACTIVATION ANALYSIS. Brit. Med. J., 1: 574(June 8, 1968).

The applications, limitations, and hazards of whole-body neutron activation analysis, with whole-body counting, in human subjects are briefly reviewed. Neutrons from a cyclotron were used to irradiate cadavers and living persons for measuring total-body Na and Ca. Though a readily detectable signal can be obtained from ^{49}Ca after neutron irradiation, the accurate estimation of total-body Ca is not possible. Its uneven concentration within the body and the skeletal variations among individuals present substantial difficulties in the analysis. The technique of using an internal standard was used in estimation of thyroid iodine, but through lack of suitable isotopes is not applicable to Ca. Results from cadavers irradiated with cyclotron-produced neutrons suggest that a change of 2% in total body Ca can be detected by activation analysis, and an accuracy of 8% in a single determination of total-body Ca, although absolute calibration of the method would require the irradiation, ashing, and chemical analysis of several cadavers. Whole-body neutron irradiation of living subjects has so far been applied only to volunteers and has involved modest (though not negligible) radiation doses. Ethical problems will be associated with neutron irradiation of patients, and will need careful study if the full benefits of this technique are to be obtained. (BBB)

49 GEOGRAPHIC CHARACTERIZATION OF CHROMIUM ORE DEPOSITS BY ELEMENTAL ANALYSIS. Kramer, Henry H.; Hampton, W. J.; Molinski, Victor J.; Finn, James J.; Wahl, Werner H. (Union Carbide Corp., Tuxedo, N. Y.). Nucl. Appl., 5: 260-73(1968).

Major and minor elemental constituents in a series of chromium ore samples were determined by neutron activation analysis. The influence of the variable amount of gangue was minimized by comparing the ratios of the concentrations of the elements believed to be associated with the chromite to the observed chromium concentration. The data obtained indicate that these ratios are significantly different, for each ore deposit examined, to be characteristic of their geographic origin. (auth)

50 ANALYSIS BY ACTIVATION. Couture, Claude. Atomes (Paris), 23: 321-2(May 1968). (In French).

Trace analysis has become increasingly important for semiconductor and strength of metals research, particularly for W, Mo, Fe, Ti, and for nuclear reactors, Hf in Zr. Activation analysis for such systems is described briefly, and limits of detection are indicated. Description of neutron activation is emphasized; it is most widely employed because of the high cross section of many elements and the penetrability of matter by neutrons. Sources, including high-flux nuclear reactors or particle accelerators producing neutrons from Be, are noted. Improvement of analysis of a complex γ spectrum by study of the rate of decay promises to improve the technique. In addition, replacement of scintillation counters by Ge—Li detectors increased sensitivity and reduced interferences. With the new detectors precision is 1 to 3% when the impurity level is 10 times the limit of detection. Physical chemical studies, analysis of Napoleon's hair, and analysis of ultrapure solids are cited as applications of the method. (BBB)

51 CONTRIBUTION TO THE STUDY OF THE DETERMINATION BY RADIOACTIVATION OF SULFUR AND OF PHOSPHORUS IN VERY LOW CONCENTRATIONS IN METALS OF VERY HIGH PURITY (ALUMINUM, MAGNESIUM, COPPER, IRON, NICKEL). PART 2. NEW CAUSE OF ERROR IN THE DETERMINATION OF SULFUR AFTER IRRADIATION WITH THERMAL NEUTRONS. Albert, Ph.; Blouri, J.; Cleyrergue, Ch.; Deschamps, N.; Le Hericy, J. (CNRS, Vitry, France). J. Radioanal. Chem., 1: 389-96(Sept. 1968). (In French).

The analytical procedure for determination of sulfur in copper by activation with thermal neutrons is given. Purifications necessary to obtain a radiochemically pure precipitate of barium sulfate are described. The occurrence of some discrepant values in the determinations led to the observation, for the first time, of abnormally high contents of $^{35}S^*$ at a relatively important depth in the samples of irradiated copper (as deep as about 300 μ). Therefore, it is necessary to etch the samples to a depth of 300 μ at least on each surface, before doing the chemical separations. Owing to the great influence of the reaction $^{35}Cl(n,p)^{35}S^*$, the determination of sulfur by thermal neutrons is possible only at contents higher than 10^{-6}, even if the chlorine concentration is very low (2×10^{-8} Cl in-

troduces a correction in terms of sulfur of the order of 10^{-6}). For sulfur contents lower than 10^{-6}, the determination is made by irradiation with fast neutrons. The analytical procedure is described and the corrections in the presence of phosphorus and chlorine are discussed. At contents of the order of 10^{-8}, the corrections are very small and the determination of some 10^{-7} of sulfur is easy. Finally, the determination of phosphorus in copper by activation in thermal neutrons is given. The chemical separations are the same as in the preceding case. Contents of the order of 10^{-8} phosphorus are determined without difficulty. The results of the determination of sulfur and phosphorus in many samples of copper are indicated. (auth)

52 1-DICARBOXYMETHYLAMINOMETHYL-2-HYDROXY-3-NAPHTHOIC ACID AS A SENSITIVE AND SELECTIVE FLUORIMETRIC REAGENT FOR BERYLLIUM, AND FOR LANTHANUM AND LUTETIUM IN PRESENCE OF THE OTHER LANTHANIDES. Budesinsky, B.; West, T. S. (Imperial Coll. of Science and Tech., London). Anal. Chim. Acta, 42: 455-65(Sept. 1968).

1-Dicarboxymethylaminomethyl-2-hydroxy-3-naphthoic acid (DHNA) forms fluorescent complexes with Al, Be, Ga, Hf, In, La, Lu, Mg, Sc, Th, Y, and Zr. The Be, La, and Lu complexes have a metal : ligand ratio of 1 : 1. The beryllium complex shows maximal fluorescence at pH 6.8 with excitation-fluorescence maxima at 360 and 450 nm; linear calibration curves are obtained in the range 0.09 to 1.8 μg Be. In the presence of the calcium–EDTA complex, of 25 cations studied, only >100-fold molar ratios of aluminium and >10-fold molar ratios of magnesium and scandium caused interference in the determination of 0.1 μmole of beryllium. Among 15 anions, >100-fold molar ratios of phosphate, >50-fold molar ratios of arsenate or oxalate and >10-fold molar ratios of citrate, fluoride and tartrate caused low results. Lanthanum and lutetium can be determined at pH 10 and 370/460 nm in the range 7 to 28 μg even in the presence of a 3-fold molar ratio of the other lanthanides without interference. (auth)

53 DIFFERENTIAL ABSORPTIOMETRIC DETERMINATION OF MOLYBDENUM IN POORLY SOLUBLE MOLYBDATES. Gorbenko, F. P.; Smirnaya, V. S.; Mokhosoev, M. V. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov, No. 29, 116-20(1966). (In Russian).

A method for the determination of Mo in the difficultly soluble molybdates of Ca, Sr, Ba, Cd, or Pb is based on the determination of the thiocyanate complex of Mo(V) after reduction of Mo(VI) with thiourea. A 0.1 g sample is dissolved in 10 ml of 1 : 3 HCl (for the molybdate of Ca, Sr, or Cd) or with 10 ml of concentrated HCl (for Pb molybdate) and diluted up to 250 ml. To 10 ml of this solution, 2 ml of 50% tartaric acid solution, 14 ml of concentrated HCl, 1.5 ml of a 4% $CuSO_4$ solution, and 15 ml of a 10% thiourea solution are added. This mixture is set aside for 10 min at ≈15°C, then 2 ml of a 50% NH_4SCN solution are added, and the solution is diluted to 50 ml. After 20 min, the extinction of the solution is measured at 550 nm relative to a blank solution containing 0.8 mg of Mo and all the reagents. The measured extinction is referred to a calibration graph. The error is <0.9% and is more accurate than the complexometric method for Mo. (Anal. Abstr.)

54 MICRODETERMINATION OF SCANDIUM, YTTRIUM, AND LANTHANUM: USE OF CHROME AZUROL S AS A CHROMOGENIC REAGENT. Sinha, Surendra N.; Sangal, Satendra P.; Dey, Arun K. (Univ., Allahabad, India). Mikrochim. Acta, No. 5, 899-902(1968).

Optimum conditions for the spectrophotometric determination of scandium, yttrium and lanthanum using Chrome Azurol S as a chromogenic reagent are described. The studies include the determination of the range for adherence to Beer's law, pH range of stability of the chelates, sensitivity, and the influence of foreign ions. (auth)

55 ANALYSIS OF SMALL SAMPLES OF MIXED ALKALINE EARTH CARBONATES. Weberling, R. P.; Cosgrove, J. F.; Bracco, D. J. (General Telephone and Electronics Labs. Inc., Bayside, N. Y.). Appl. Spectrosc., 22: 527-31(Sept.-Oct. 1968).

The application of instrumental techniques to the analysis of barium, calcium, and strontium in milligram-size samples of mixed alkaline earth carbonates was examined. The techniques investigated were atomic absorption spectroscopy, flame photometry, and x-ray fluorescence spectroscopy. The instrumental methods were evaluated on the basis of ease of manipulation, accuracy, and precision. Of the three methods, only atomic absorption spectroscopy fulfilled all the requirements of precision and simplicity. It is a rapid analytical method which does not require chemical separations. Precision of 1% to 2% for each of the elements is obtainable with milligram-size samples. (auth)

56 ATOMIC ABSORPTION SPECTROMETRY: APPLICATIONS AND PROBLEMS. Lewis, L. L. (General Motors Corp., Warren, Mich.). Anal. Chem., 40: 28A-36A; 39A-47A(Oct. 1968).

A review of atomic absorption spectrometry (AAS) is presented that includes comparison with other chemical methods (gravimetric, titrimetric, photometric, and electrochemical), and discussion of the absolute detection limits, accuracy, precision, and errors from losses and contamination. Present uses of AAS and practices recommended for the best accuracy are also considered. The need for critical evaluations and interlaboratory testing of AAS methods is discussed. (D.H.M.)

57 ANALYTICAL METHODS BASED UPON BACK SCATTERING AND ABSORPTION OF THE RADIOACTIVE RADIATION. VI. DETERMINATION OF α-BROMOISOVALERYL UREA AND ZINC OXIDE IN A MIXTURE OF ORGANIC SUBSTANCES BY THE METHOD OF BACK SCATTERING OF γ-RADIATION. Havranek, E.; Schiller, P. (Komensky Univ., Bratislava). Chem. Zvesti, 22: 584-90(1968). (In Czech).

α-Bromoisovalerylurea and zinc oxide were determined in pharmaceutical preparations by a method based upon the back scattering of ^{241}Am γ-radiation. The rapid, nondestructive process is suitable mainly in industrial production for checking drugs which could be regarded as a binary mixture. (auth)

58 OBSIDIAN SOURCES CHARACTERIZED BY NEUTRON-ACTIVATION ANALYSIS. Gordus, Adon A.; Wright, Gary A.; Griffin, James B. (Univ. of Michigan, Ann Arbor). Science, 161: 382-4(July 26, 1968).

Concentrations of elements such as manganese, scandium, lanthanum, rubidium, samarium, barium, and zirconium in obsidian samples from different flows show ranges of 1000% or more, whereas the variation in element content in obsidian samples from a single flow appears to be less than 40%. Neutron-activation determination of these elements, as well as of sodium and iron, provides a means of identifying the geologic source of an archeological artifact of obsidian. (auth)

59 NEUTRON ACTIVATION FOR DISTINGUISHING CASCADE RANGE PYROCLASTICS. Theisen, Arthur A.; Borchardt, Glenn A.; Harward, Moyle E.; Schmitt, Roman A. (Oregon State Univ., Corvallis). Science, 161: 1009-11(Sept. 6, 1968).

Neutron activation of glassy separates of volcanic ash resulted in 21 nuclides measurable with instrumental techniques. The relative activities of most of the nuclides distinguish samples from Mount Mazama, Newberry Crater, and Glacier Peak. The usefulness of the technique was assessed by comparing the values for known sources with those from fine ash of uncertain origin. The data strongly suggest Mount Mazama as the source. (auth)

60 COMPLEXATION OF URANIUM BY 2-(2-THIAZOLYLAZO)-4-METHOXYPHENOL AND 2-(2-THIAZOLYLAZO)-5-METHOXYPHENOL. Sommer, L.; Sepel, T.; Ivanov, V. M. (Purkyne Univ., Brno). Talanta, 15: 949-61(Sept. 1968).

A comparative study was made of the complexation of uranium(VI) by 2-(2-thiazolylazo)-4-methoxyphenol (TAMH) and 2-(2-thiazolylazo)-5-methoxyphenol (TAMR). The complexes are less stable and have lower molar absorptivities than the 4-(2-pyridylazo) resorcinol (PAR) and 4-(2-thiazolylazo) resorcinol (TAR) complexes but are still useful for determination of uranium. The TAMH chelate can be extracted into isobutyl methyl ketone. Both complexes are 1 : 1 metal : ligand. For the TAMH complex $\log \beta_1 = 8.8$, $\epsilon = 1.4 \times 10^4$ at 610 mμ; for the TAMR complex $\log \beta_1 = 8.1$, $\epsilon = 2.0 \times 10^4$ at 530 mμ. (auth) (UK)

61 ELECTROTHERMAL ATOMIZATION FOR ATOMIC ABSORPTION ANALYSIS. Woodriff, Ray; Stone, Ronald W.; Held, Andrew M. (Montana State Univ., Bozeman). Appl. Spectrosc., 22: 408-11(Sept.-Oct. 1968).

In recent years atomic absorption in flames has been extensively applied to the analysis of both industrial and geologic materials. Now the application of electrically heated tubes for evaporation and atomization of samples promises to provide the basis for even greater sensitivity and accuracy. In the furnace, there is an inert, nonturbulent, slow moving atmosphere with a controllable uniform temperature. The gas stream in the furnace is at a lower temperature than the walls. This tends to force suspended particles to the center where they evaporate and pass on into the light beam. It also tends to minimize or eliminate memory effects and matrix effects. The operation of the furnace is described and results are given for the analysis of samples containing diverse matrix elements. (auth)

62 HIGH PRECISION ACTIVATION ANALYSIS OF SODIUM WITH AN INTERNAL STANDARD TECHNIQUE. Marsh, R. H.; Allie, W. Jr. (Ford Motor Co., Dearborn, Mich.). Anal. Chem., 40: 2037-40(Nov. 1968).

The use of neutron activation analysis in the determination of

macro amounts of sodium in a material that can be readily solubilized only by a basic fusion was investigated. In order to avoid mapping neutron fluxes in reactors and maintaining strictly uniform counting geometry, an internal standard was used. Approximately 10 mg of As_2O_3 and 20 mg of Na_2CO_3 were accurately weighed into series of 1-cm long polyethylene vials. The powders were mixed thoroughly and the stirring rod and walls of the vial were washed down with anhydrous diethyl ether that was saturated with polystyrene. The ether was evaporated and the vial filled with molten polyethylene. Pure arsenic and sodium background blanks were prepared similarly. The standards and ceramic samples were then irradiated for 4 min and cooled overnight. Sources of errors and ways of correcting them are discussed. Ceramic samples were analyzed on a routine basis with the method but without a digital spectrum stabilizer or total peak integration. The standard deviation for a single determination was consistently within 1.5%. More recent work indicates that 10 mg of copper oxide can be substituted for arsenic oxide, greatly reducing errors caused by the epithermal neutron flux. (D.H.M.)

63 USE OF ALKYLPHENOL SURFACTANTS FOR LIQUID SCINTILLATION COUNTING OF AQUEOUS TRITIUM SAMPLES. Greene, Ronald C.; Patterson, Michael S.; Estes, Alice H. (Duke Univ., Durham, N. C.). Anal. Chem., 40: 2035-7(Nov. 1968).

The use of various members of the Triton series of surfactants for liquid scintillation counting was studied and mixtures were defined in which aqueous samples can be solubilized or emulsified that are suitable for counting tritium from below 0°C to above room temperature. A procedure for removing impurities in Triton emulsifiers that emit light when mixed with alkaline solutions was devised. The temperature-dependent phase transitions of mixtures containing 20% water and 80% of a solution of 1 part of Triton in 2 parts of toluene were investigated. A typical mixture is milky and mobile at high temperature; as the mixture is cooled a single clear mobile phase forms which persists for a few degrees and then becomes cloudy and viscous. On further cooling, the mixture becomes clearer and more viscous till the freezing temperature is reached and the emulsion breaks. Either the clear mobile solution or the translucent viscous emulsion may be used for counting. The temperatures at which these transitions occur are a function of the length of the polyethylene glycol chain of the Triton surfactant and thus differ with each member of the series. The temperature range over which the mixtures form homogeneous solutions can be adjusted to any desired value by the use of appropriate mixtures of Triton surfactants. For emulsion counting Triton X-102 has the greatest utility for it can be used over a much wider temperature range. (D.H.M.)

64 ANALYSIS OF A TERNARY NIOBATE [OF LEAD, CALCIUM, AND STRONTIUM]. Gorbenko, F. P.; Tselinskii, Yu. K.; Lapitskaya, E. V.; Kuchkina, E. D.; Kiseleva, N. E. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov, No. 29, 92-8(1966). (In Russian).

Separate samples are used and separate procedures are given for determining Pb, total Ca and Sr, and Nb. For the Pb determination, 0.1 g of the samples is dissolved by heating with 10 ml of concentrated H_2SO_4 and 1.5 g of $(NH_4)_2SO_4$. The solution is cooled, and 25 ml of 15% tartaric acid are added. After 30 min, the combined precipitate of $PbSO_4$, $CaSO_4$, and $SrSO_4$ is collected and washed twice with 5% H_2SO_4. The precipitate and the filter are boiled with 50 ml of acetate buffer solution of pH 5 to 5.5 for 5 min, and the solution is diluted to 100 ml. Xylene orange–KNO_3 (0.1 g of 1:100) is added as an indicator, and the Pb is titrated with 0.01 N EDTA to produce a pure-yellow solution. To determine the total Ca and Sr, another 0.1 g sample is dissolved as before; the solution is evaporated to 1 to 1.5 ml, and 50 ml of a tartrate buffer solution (25 g of tartaric acid dissolved in 300 ml of H_2O with 100 ml of aqueous NH_3 added and diluted to 1 l) are added. The solidified mass is extracted, and the solution is diluted to 100 ml. Before dilution, if the solution is turbid, aqueous NH_3 is added to clarify it. To a 25 ml aliquot of this solution, 1.5 ml of a 5% unithiol (Na 2,3-dimercaptopropane-1-sulfonate) solution is added to mask the Pb. Then 50 ml of H_2O, 20 ml of concentrated aqueous NH_3, 2 ml of a 5% Mg–EDTA complex solution, and 0.1 g of methylthymole blue–KNO_3 (1:100) is added as an indicator. The solution is titrated with 0.01 N EDTA to a color change from blue to grey. For determination of Nb, another 0.1 g sample is dissolved, cooled, and diluted to 100 ml with concentrated H_2SO_4. To 10 ml of this solution, 0.5 ml of 33% aqueous H_2O_2 are added, and the solution is diluted to 50 ml with concentrated H_2SO_4. The extinction of the solution is measured at 365 mμ against a solution containing 2.5 mg Nb_2O_5. The Nb content is found from a calibration graph. The complete analysis takes ≈2 hr, and the error is <±1%. (Anal. Abstr.)

65 ANALYSIS OF DIGITAL DATA FROM A MULTICHANNEL PULSE HEIGHT ANALYZER ON GAMMA RAY TOTAL ABSORPTION PEAKS IN ACTIVATION ANALYSIS. Sterlinski, Slawomir (Inst. of Nuclear Research, Warsaw). Anal. Chem., 40: 1995-8(Nov. 1968).

Two problems concerning the digital method of examination of gamma-ray spectrograms are discussed. A modification of the known Covell's formula improves the precision of determinations based on poor counting statistics and the detection and the evaluation of the systematic error, which is caused by the curvilinear character of background under total absorption peaks. Both the problems were studied assuming that the stability of the analyzer is such that the shift of the total absorption peak in the spectrum can be neglected, and that the counts in two neighboring channels of the analyzer are independent of each other. (auth)

66 NEUTRON CAPTURE GAMMA-RAY ACTIVATION ANALYSIS USING LITHIUM DRIFTED GERMANIUM SEMICONDUCTOR DETECTORS. Lombard, S. M.; Isenhour, T. L. (Univ. of Washington, Seattle). Anal. Chem., 40: 1990-4(Nov. 1968).

The performances of a planar and a coaxial Ge(Li) semiconductor gamma-ray detector are compared with that of NaI(Tl) scintillation detector for neutron capture gamma-ray activation analysis. The superior resolution of these large volume Ge(Li) diodes more than compensates for their lower efficiency because post-irradiation chemical or half-life resolution is not possible in the capture gamma-ray method. Data are given for the efficiency, resolution, and observed background of the detectors; several sample containers are compared; and detection limits for 18 elements in aqueous solution are presented. (auth)

67 DIRECT DETERMINATION OF ^{210}Pb BY LIQUID SCINTILLATION COUNTING. Fairman, William D.; Sedlet, Jacob (Argonne National Lab., Ill.). Anal. Chem., 40: 2004-8 (Nov. 1968).

The soft betas, 15- and 61-keV end-point energies, the internal conversion electrons, and unconverted gamma rays from ^{210}Pb are efficiently detected in a liquid scintillation counting system. The overall counting efficiency (cpm/dpm) is 97 to 98%. The background counting rate in the ^{210}Pb window is 20 cpm for polyethylene vials and 40 cpm for low-potassium glass vials. It is possible to determine 0.98 ± 0.58 pCi of separated ^{210}Pb at the 95% confidence level in a 100-minute sample counting period, with polyethylene vials. The ^{210}Pb can also be measured in the presence of its daughter activities, ^{210}Bi and ^{210}Po. Both the ^{210}Bi beta (1.160-MeV end-point energy) and the ^{210}Po alpha (5.305-MeV) are counted at essentially 100% efficiency. There is no interference between the ^{210}Pb and ^{210}Po spectral counting regions. The ^{210}Bi beta spectrum overlaps the ^{210}Pb and ^{210}Po spectral regions; 23 and 50% of the ^{210}Bi beta particles appear in the lead and polonium regions, respectively. However, an energy range covering approximately 27% of the bismuth spectrum is completely free of ^{210}Pb and ^{210}Po activity. It is thus possible to determine the concentration of each component of a ^{210}Pb–^{210}Bi–^{210}Po mixture. (auth)

68 QUANTITATIVE INTERPRETATION OF GAMMA-RAY SPECTRA. Liebscher, Kurt; Smith, Hamilton (Glasgow Univ.). Anal. Chem., 40: 1999-2004(Nov. 1968).

A peak fraction method of interpretation of gamma-spectra is described. A computer technique is proposed for work under varying conditions which consists of successive applications of a series of procedures. Curves are smoothed and calibrated peak fraction areas are calculated. For peak fraction calibration, the points of inflection on a third order approximation curve are used. The shape of the peak fractions is checked with normalized Gaussian curves. This method permits work without a catalog of standard spectra and gives better results than spectrum stripping in the lower energy region of composite spectra. It is suitable for the interpretation of trace elements in biological materials. (auth)

69 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM WITH 2-(1-HYDROXY-4,6-DINITRO-2-PHENYLAZO)-1,8-DIHYDROXYNAPHTHALENE-3,6-DISULPHONATE (PICRAMINE CA) AS CHROMOGENIC REAGENT. Goyal, S. S.; Tandon, J. P. (Univ. of Rajasthan, Jaipur, India). Talanta, 15: 895-9 (Sept. 1968).

2-(Hydroxy-4,6-dinitro-2-phenylazo)-1,8-dihydroxynaphthalene-3,6-disulfonate was used as a selective reagent for the microdetermination of zirconium in acidic medium (0.5M HCl) and found to be better than Picramine R. Spectrophotometric studies showed the formation of a 2:1 (ligand:Zr) water-soluble complex and the reaction is suitable for photometric determination of 0.4 to 2.8 ppM of zirconium. The color takes about 90 min to develop fully and is stable for about 20 hr. The molar absorptivity of the com-

plex is 2.4×10^4 and the equilibrium constant is of the order of 10^{10}. The interference due to a number of ions was studied. (auth) (UK)

70 A NEW REAGENT FOR THE FLUOROMETRIC DETERMINATION OF TERBIUM(III) AND DYSPROSIUM(III) IN AQUEOUS SOLUTION, BIS[1(2)-PYRIDYL-3-METHYL-5-PYRAZOLONYL]-4,4'-METHANE. Butter, E.; Kolowos, I.; Holzapfel, H. (Karl-Marx Univ., Leipzig). Talanta, 15: 901-11(Sept. 1968). (In German).

The compound bis[1(2)pyridyl-3-methyl-5-pyrazolonyl]-4,4'-methane was synthesized from 1(2)-pyridyl-3-methyl-5-pyrazolone and hexamethylenetetramine, and the structure was proved by determination of the molecular weight and uv, ir and NMR spectra. The fluorescence spectra of aqueous solutions of the Tb- and Dy- and Sm-complexes, and the dependence of the relative fluorescence intensity on the pH-value, on the metal : reagent ratio and on other rare earth ions were investigated. The determination of Dy(III) and Tb(III) in other rare earths is described. (auth) (UK)

71 CALIBRATION TECHNIQUE FOR COUNTING ^{85}Kr IN CHARCOAL TRAPS. Seifert, D. A.; Stuart, R. L. (General Electric Co., Cincinnati). Anal. Chem., 40: 2080(Nov. 1968).

A method was developed for calibrating a detector for counting radioactive krypton or xenon isotopes adsorbed by charcoal traps that does not require a standard gas sample, but does require some method, such as an ion bombardment system or modified mass spectrometer, for impregnating a thin metal foil with some of the radioactive krypton or xenon. Following the bombardment the foil is counted on a previously calibrated detector, and the photon emission rate is determined. A portion of the radioactive gas, released by heating the foil in a partial vacuum, is collected by a charcoal filled trap at liquid nitrogen temperatures. The residue from the foil is then counted, and the amount of radioactive gas which was transferred to the trap is determined by difference. A calibration factor for any desired spatial arrangement of trap and detector may be obtained by simple division from the counting data obtained. (D.H.M.)

72 SPECTROCHEMICAL ANALYSIS OF ZIRCONIUM AND ITS ALLOY. VI. SPECTROGRAPHIC DETERMINATION OF BORON AND CADMIUM IN ZIRCALOY-2 BY THE OXIDE POWDER-D.C. ARC TECHNIQUE. Mizuno, Tomomi; Matsumura, Tetsuo; Nishizaki, Kyoji (Kobe Steel Ltd., Japan). Nippon Kinzoku Gakkaishi, 32: 645-50(1968). (In Japanese).

The method for determination of boron and cadmium in Zircaloy-2 by the dc arc spectrographic technique was developed. The metal sample was converted into the oxide, 100 mg of which in a graphite electrode were excited by a dc arc at 14 A. Exposure conditions were extremely critical. Precision of the method was 20 to 25% with satisfactory results in routine analysis. (auth)

73 X-RAY FLUORESCENCE ANALYSIS OF IRON, NICKEL, AND COPPER IN TITANIUM-AND ZIRCONIUM-BASED ALLOYS BY AN AQUEOUS SOLUTION METHOD. Goto, Hidehiro; Saito, Akira (Tohoku Univ., Sendai). Nippon Kinzoku Gakkaishi, 32: 690-3(1968). (In Japanese).

A simple, rapid, and accurate method is described for determination of iron, nickel, and copper in samples that contain some refractory metals. Samples are dissolved in a nitric and hydrofluoric acid mixture, and saturated boric acid solution is added to the solution to mask excess hydrofluoric acid. Iron, nickel, and copper are determined directly in the final sample solution by x-ray fluorescence analysis. The effect of the element of interest was negligible below 2 N. The interelement effects of iron, nickel, and copper, however, were large, so that a correction had to be considered. This proposed method is so rapid that it took only about 10 minutes for analysis of one sample. The relative errors were below 3%. This method, may have a broad applicability in the analysis of refractory metals. (auth)

74 DETERMINATION OF NIOBIUM IN HIGH ALLOY STEEL BY THE SPECTROPHOTOMETRIC METHOD. Sakaki, Takashi (Japan Special Steel Co., Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 790-6(1968). (In Japanese).

An experiment was carried out to establish a simple and accurate method for the determination of niobium in high-alloy steel. The niobium was separated as pentaoxide from other elements by hydrolysis with sodium sulfite and tannic acid, and the separated niobium was determined by spectrophotometry with xylenol orange. This method is not affected by the presence of 0.1 mg of chromium, 0.2 mg of cobalt, 1 mg each of antimony, manganese, tantalum and tin, 20 mg of molybdenum, 10 mg of titanium and 60 mg of tungsten in the separated sample solution. The presence of aluminum, bismuth, copper, iron, nickel, vanadium, and zirconium is found to interfere. However, this interference can be eliminated by the use of EDTA. As a result of the experiment, a method was established in which 0.02 to 6% of niobium in high-alloy steel can precisely be measured without difficulty. The niobium contents in synthetic and actual samples were measured by this method with satisfactory results. (auth)

75 A RADIOCHEMICAL SEPARATION FOR THE DETERMINATION OF ZIRCONIUM OR HAFNIUM IN ROCKS AND MINERALS BY NEUTRON ACTIVATION ANALYSIS. Brooks, C. K. (Dept. of Geology and Mineralogy, Oxford). Radiochim. Acta, 9: 157-60(Aug. 1968).

A new separation scheme for use in the neutron activation analysis of natural silicates for Hf is presented, which may be applied to a greater range of sample compositions and gives higher yields than previously published methods. Data are presented for the Hf concentrations of a number of international rock standards. (auth)

76 APPLICATION OF Ge(Li) DETECTOR TO THE DETERMINATION OF MANGANESE IN ZIRCONIUM ALLOYS BY ACTIVATION ANALYSIS. Espanol, Carlos E.; Marafuschi, Ana Maria (Univ., Buenos Aires). Radiochim. Acta, 9: 165-6 (Aug. 1968).

A method is described for the determination of Mn impurities in Zircaloy and Zr by means of activation with thermal neutrons and gamma spectrometry. Differences between a gamma spectrum of a Zr alloy sample obtained with a NaI(Tl) scintillator crystal and with a Ge(Li) semiconductor detector are illustrated. It was concluded that a direct analysis without chemical separation by γ spectrometry with a NaI(Tl) crystal is not suitable for this purpose. A comparison was also made between the nondestructive method using a Ge(Li) semiconductor with a radiochemical separation method using a NaI(Tl) crystal. The results were in good agreement. (P.C.H.)

77 CATALYTIC DETERMINATION OF SMALL AMOUNTS OF RUTHENIUM. Reznik, B. E.; Bednyak, N. A. (Dnepropetrovsk State Univ., USSR). Zh. Anal. Khim., 23: 1502-5(Oct. 1968). (In Russian).

The reaction kinetics of the reduction of an iron thiocyanate complex by stannous chloride in the presence of ruthenium(III) ions as a catalyst has been studied and the possibility of determining small amounts of ruthenium is shown. Optimum conditions for the reaction have been found, a kinetic equation is suggested, and the catalytic coefficient has been calculated. The minimum determinable concentration of ruthenium at 25°C is 3.7×10^{-7} M. The effect of foreign ions has been studied. (auth)

78 NEW DATA ON THE THEORY AND PRACTICAL USE OF THE β-RADIATION BACK SCATTERING METHOD (A REVIEW). Boyarshinov, L. M. (All-Union Correspondence Energetic Inst., Moscow). Zh. Anal. Khim., 23: 1522-31(Oct. 1968). (In Russian).

Many notions on the theory of β-radiation back scattering have been specified during recent years. New data on the relationship between the composition of the substance and the intensity, the angular and energetic distribution of back scattered electrons and positrons are reviewed. The possibility has been shown of increasing the sensitivity of the β-radiation back scattering method by using the most hard part of the back scattered spectrum, the repeated back scattering and combined radiation sources. The method is still developing and its application to the analysis of various two-component mixtures widens. The β-radiation back scattering method can be used for the analysis of multicomponent mixtures in the combination with some other methods. (78 references) (auth)

79 ANALYTICAL CHEMISTRY OF THORIUM. COMMUNICATION 5. DETERMINATION OF SMALL AMOUNTS OF THORIUM IN RARE EARTH PREPARATIONS. Luk'yanov, V. F.; Nikol'skaya, I. V. Zh. Anal. Khim., 23: 1567-8(Oct. 1968). (In Russian).

The effects of a number of rare earth elements on the determination of thorium with Arsenazo III have been studied. It has been found that this effect decreases as the atomic number of the rare earth element increases. A method has been developed for determining more than 2×10^{-4}% of thorium in rare earth preparations with a relative error of not more than ±20%. (auth)

80 DETERMINATION OF ARSENIC IN BIOLOGICAL MATERIALS BY MEANS OF NEUTRON ACTIVATION ANALYSIS. Dukenbaeva, A. B.; Smirnov, V. F. (Central Inst. for the Advanced Training of Physicians, Kiev). Gig. Sanit., 33: No. 6, 67-70(June 1968). (In Russian).

In view of the difficulties involved in the early diagnosis of arsenicalism, development of method for detecting arsenic in an organism in amounts of 1 ppM is of great importance. Neutron activation was found to satisfy the requirements. Tissue specimens were irradiated by slow neutrons, together with a reference

specimen containing a known amount of arsenic. The ^{76}As formed by neutron capture may be determined on the basis of its activity but it must be separated radiochemically from other radioisotopes. The absolute sensitivity of the neutron activation method for arsenic lies between 10^{-5} and 10^{-10} g. The determination is based on the γ spectrum of ^{76}As after chemical treatment. Preliminary tests with persons who were exposed to arsenic revealed that the hair contained 0.011 to 2.8 μg of As per g of hair. (TTT)

81 DETERMINATION OF RADIOACTIVE STRONTIUM AFTER SEPARATION BY EDTA ON CATIONIC RESIN. Bouquiaux, J.; Gillard-Baruh, J. H. C. (Ministere de la Sante Publique, Brussels). Radiochim. Acta, 9: 153-7(Aug. 1968). (In French).

A method for ^{90}Sr and ^{89}Sr determination is described for different types of samples, such as: rainwater-air dust, river and sea water, food products (milk, wheat, complete meals) and bones. The sample solution (ashes in hydrochloric acid or acidified water sample) is passed through an acid Dowex column for anion elimination. The cations are eluted by means of hydrochloric acid and the alkaline earth carbonates are precipitated with ammonium carbonate. The precipitate is dissolved in EDTA, and after the p_H has been adjusted to 4.8, the solution is passed through an ammoniacal Dowex column on which strontium and barium, and part of calcium are retained. The strontium is then selectively and quantitatively eluted by means of an EDTA solution adjusted at p_H 6. The ^{90}Sr content is then calculated from the ^{90}Y activity. (auth)

82 DETERMINATION OF LITHIUM BY MEASUREMENT OF $^{7}Li(p,\gamma)^{8}Be$ REACTION YIELD. Vasil'ev, S. S.; Mikhailov, G. I.; Starchik, L. P.; Konanykin, L. V. At. Energ. (USSR), 25: 328-9(Oct. 1968). (In Russian).

A sensitive method for the determination of lithium using proton radiative capture in the $^{7}Li(p,\gamma)^{8}Be$ reaction at a proton energy of $\leq$1.5 MeV is described. Experiments were made using an electrostatic accelerator with proton energy of 900 keV, 2 μa current beam, and a beam cross section of 3.0 cm^2. A scintillation spectrometer with 8.0 × 8.0 cm NaI(Tl) crystal was used for γ radiation detection. Gamma quanta spectra obtained by proton irradiation of Li_2O and H_3BO_3 targets are analyzed. (R.V.J.)

83 ACTIVATION ANALYSIS AS AN ANALYTICAL METHOD IN THE MANUFACTURE OF VALVES. Schmied, H.; Ziffermayer, G. (Brown Boveri Co., Ltd., Baden, Switzerland). Microtecnic (Lausanne), 22: 292-4(August 1968).

Activation analysis was used to follow the diffusion behavior of the various component metals in the construction of control grids for high-frequency valves. Mixtures of platinum and rhenium with molybdenum, tantalum, and tungsten were analyzed for their platinum and rhenium content. Activation analysis was also used for determining thorium content in tungsten wires used as cathodes in vacuum valves. Relative accuracy of the analyses was ±5%. (J.G.B.)

84 SODIUM ANALYSIS BY SPARK SOURCE MASS SPECTROGRAPHY. Berkey, Edgar; Sweeney, George C.; Hickam, William M. (Westinghouse Research Labs., Pittsburgh). Nucl. Appl., 5: 344-53(Nov. 1968).

The feasibility of using spark-source mass spectrography for a direct multi-element analysis of solid sodium is demonstrated. Two different sparking configurations are employed, one with the capability of obtaining local analyses and the other bulk analyses. Sample handling and preparation are minimal. Both argon and vacuum are used to protect the sodium prior to analysis. Liquid nitrogen cooling applied to the sodium while sparking inhibits melting and preferential volatilization. Detection limits below 100 ppb atomic are readily attained, and there is reasonable agreement with emission spectrographic results. The analysis of doped solutions further confirms the applicability of the technique. (auth)

85 OPTICAL ^{15}N ANALYSIS OF SMALL NITROGEN SAMPLES WITH A MIXTURE OF HELIUM AND XENON TO SUSTAIN THE DISCHARGE IN AN ELECTRODELESS TUBE. Goleb, J. A.; Middelboe, V. (International Atomic Energy Agency, Seibersdorf, Austria). Anal. Chim. Acta, 43: 229-34(Nov. 1968).

A spectrographic technique was developed for the determination of the ^{15}N abundance, with a mixture of rare gases, helium and xenon, to sustain the nitrogen discharge. The average natural abundance obtained with 0.2-μg samples of nitrogen was 0.370 ± 0.005 at. %. Preliminary work indicates that this method is applicable directly to plant and liquid samples. (auth)

86 DETECTION OF METHYL IODIDE UPON HEATING IRRADIATED FUELS. Taketani, Kiyoaki; Ikawa, Katsuichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Tech. (Tokyo), 5: 491-7(Oct. 1968).

Laboratory scale experiments were carried out to obtain information on the sources of CH_3I, reported by various workers to have been detected under accidental conditions of fuels. Small pieces of slightly irradiated sintered UO_2 and U metal turnings were heated externally up to 1,400°C in various carrier gases, and the carrier gases were analyzed for fission product iodine present in the form of CH_3I. It is concluded that in the case of sintered UO_2, some amount of CH_3I is released directly from the fuel below 600°C, whereas in case of U metal turnings, direct release does not apparently occur at any temperature. In oxidizing atmospheres, iodine released from either sintered UO_2 or U metal is considered to change into CH_3I only to a small extent, probably by gas phase formation. (auth)

87 DETERMINATION OF SILICON IN STEEL BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Van Grieken, R.; Gijbels, R.; Speecke, A.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 43: 199-210(Nov. 1968).

A fast (2 to 5 min) non-destructive determination of silicon in steel by 14-MeV neutron activation is described. The 1.78-MeV ^{28}Al activity, induced by the reaction $^{28}Si(n,p)^{28}Al$, is counted on a NaI(Tl) detector. An oxygen flux monitor is used to normalize to the same neutron flux. Two methods are described to correct for the ^{56}Mn activity (2.58 h), induced into the iron matrix via $^{56}Fe(n,p)^{56}Mn$. Nuclear interferences of phosphorus and aluminum were examined. Special attention was paid to stainless steels. A sensitivity of 0.02 to 0.05% of silicon is obtained. The precision is 2 to 3% for steels containing above 1% silicon, and 7% for 0.1% of silicon. (auth)

88 OXYGEN STANDARD FOR THE DETERMINATION OF OXYGEN IN STEEL BY 14-MeV NEUTRON ACTIVATION ANALYSIS. Gijbels, R.; Speecke, A.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 43: 183-98(Nov. 1968).

A relative method for the determination of oxygen in steel via the $^{16}O(n,p)^{16}N$ reaction by means of 14-MeV neutrons is described. A standard is irradiated immediately behind the sample disks and the induced activities are counted simultaneously with two separate but identical detector systems. The standard mixture (ca. 5 g of graphite plus iron oxide containing 80.00 mg of oxygen per g) is compressed into a steel capsule of the same external dimensions as the samples (26 mm diameter, 9 mm thick). Dimensional tolerances, choice, and purity control of the oxygen compound, and preparation of the standard mixture are discussed. Fast neutron shielding, absorption of fast neutrons, self-absorption of the ^{16}N γ-rays, and the average neutron flux in sample and standards are considered and a total correction factor is established. Flux inhomogeneities and differences in counting geometry and discriminator setting can be determined by irradiation and counting of two identical standards. The accuracy of this method was checked by comparison of the results with those of the reducing fusion method; satisfactory agreement was observed, although the activation results tended to be slightly higher. The mean long-term standard deviation for analysis of a given sample over a period of 6 months was found to be ±3%. (auth)

89 DETERMINATION OF LOW LEVELS OF ^{210}Po IN ENVIRONMENTAL MATERIALS. Flynn, W. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Anal. Chim. Acta, 43: 221-8(Nov. 1968).

A method is presented for the determination of ^{210}Po at very low levels in the presence of many different ions. Essentially quantitative recoveries were obtained in 60 min by deposition on to a silver plate in a special holder from 50 ml solution at 85 to 90°C with sodium citrate present. (auth)

90 THE APPLICATION OF TRITON X 100 COLLOID SCINTILLATION COUNTING IN BIOCHEMISTRY. Fox, B. W. (Christie Hospital, Manchester, Eng. Holt Radium Inst., Manchester, Eng.). Int. J. Appl. Radiat. Isotop., 19: 717-30(Oct. 1968).

The optimal compositions of Triton X 100 : toluene solutions of PPO (2,5-diphenyl oxazole) and POPOP (2,2'-p-phenylenebis[5-phenyloxazole]) are described for assaying tritium and ^{14}C labelled substances in 5% trichloracetic acid and 5% perchloric acid extracts, 2M sodium chloride, 5% sucrose, and 8M urea solutions. The method is described specifically for near ambient temperature counting (25°C). The optimal compositions are determined by comparing phase diagrams assessed at room temperature (21°C) and merit contours assessed at instrument sample changer temperature (25°C) using triangular co-ordinates, and the stability of the colloid by repeated counting. By careful choice of Triton X 100 : toluene : aqueous solution ratios, it is possible to count from 1.5 to 5.0 ml of these solutions directly at 9 to 20% efficiency for tritium, and 73 to 85% efficiencies for ^{14}C, without preliminary processing. (auth) (UK)

91 ATOMIC ABSORPTION CHARACTERISTICS OF BISMUTH AND VANADIUM WITH NOTES ON BORON AND URANIUM. Marshall, Delbert Allan. Manhattan, Kansas, Kansas State Univ., 1968. 118p.

Thesis.

An investigation of the atomic absorption characteristics of Bi, V, B, and U was undertaken. Optimum operating conditions were determined, then flame intensity profiles were obtained, analytical curves prepared, the sensitivities and limits of detection determined, and interference studies were carried out. For Bi, the most sensitive spectral line was found to be at 3067.72 Å using a hollow-cathode-lamp current of 8 mA. The sensitivity was found to be 2.0 μg Bi/ml and the limit of detection was approximately 1 μg/ml. Interference studies were conducted with the ions Ag(I), As(III), Cd(II), Cu(II), Hg(II), Ni(II), Pb(II), Sb(III), Sn(IV), Zn(II), Cl^- PO_4^{3-}, and SO_4^{2-}. None of these ions was found to interfere in the bismuth determination in concentrations up to fifty times that of the Bi concentration present. The determination of V was found to be feasible in the range from 15 to 1,000 μg V/ml using a single burner and a single optical pass through the flame. Ions tested for interference in the vanadium determination were Al(III), Bi(III), Cr(VI), Fe(III), K(I), Li(I), Na(I), Sb(III), Ti(IV), Zr(IV), $C_2H_3O_2^-$, and PO_4^{3-}. All were found to interfere in this determination. The sensitivity was found to be 13.5 μg V/ml and the limit of detection was approximately 15 μg V/ml. The most sensitive line for the determination of B was found to be the unresolved doublet at 2497.7/2496.8 Å. For U, the most sensitive analytical line appeared to be the 3499.3 Å line. Due to excessive flame noise and burner clogging produced by the concentrated solutions which had to be used, no further data on U or B was obtained. (Disser. Abstr.)

92 PREPARATION OF ZIRCALOY STANDARD SAMPLES FOR SPECTROCHEMICAL ANALYSIS. Kashu, Seiichiro (Japan Vacuum Engineering Co., Ltd.); Nakajima, Tokunosuke. Nippon Kinzoku Gakkaishi, 32: 919-25(Sept. 1968). (In Japanese).

Preparation of Zircaloy standard samples for spectrochemical analysis by using a 120-kW electron beam skull furnace is described. Major elements (Sn, Fe, Ni, and Cr) and impurity elements, such as Al, Cu, Ti, Si, Co, B, and Hf, were observed before and after the skull casting. Three major elements (Sn, Fe, and Ni) in Zircaloy can be controlled to within ±10% of the respective predicted preset level, provided each content in the skull is controlled to within ±50% of a predetermined value. Chromium showed a low and scattered yield. Composition analysis of major elements in the upper, middle, and lower parts of an ingot showed less than 4% deviation in Sn, 8% in Fe and Ni, and 11.1% in Cr from the average contents in the ingot. Impurity elements of B, Ti, Si, and Al in Zircaloy can be controlled to within ±15% of the preset level. Yields of Cu and Co are less than 20% and widely scattered results are obtained, even if the 120-kW rotated electron beam is used. Chemical analysis of impurity elements in the upper, middle, and lower parts of the ingot showed less than 5.2% deviation in Ti and less than 10% in B, Si, Co, Cu, and Al from the average contents of the respective elements. In skull melting of the alloy, there is an active zone near the surface of the skull, which reacts with the molten pool. For the control of the Al or Ti content in Zircaloy the surface layer of the skull up to 5 mm in depth is estimated to be reactive. (NSA of Japan)

93 ISOTOPIC COMPOSITION OF URANIUM AND ACTINIUM IN MINERALS AND NATURAL WATERS. Kadyrov, N. B.; Isabaev, E. A.; Asylbaev, U. Kh.; Abil'daev, A. Kh.; Cherdyntsev, V. V. (Alma-Ata Kazakh State Univ., USSR. Moscow Inst. of Geology). Geokhimiya, No. 4, 492-4(Apr. 1968). (In Russian).

The ratios $^{234}U/^{238}U$, $^{235}U/^{238}U$, and $^{227}Ac/^{226}Ra$ in minerals and waters were studied by the electrolytic precipitation of uranium on stainless steel plates. The ratio $^{235}U/^{238}U$ was determined by radiometric methods using neutron flux from a polonium–beryllium source; an α spectrometer was used for determining the ratio $^{234}U/^{238}U$; and the ratio Ac/Rc was determined by measuring the content of radon and actinium by the decay coincidence method. Data obtained for various sulfide and rare earth specimens are tabulated. (R.V.J.)

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Refer also to abstracts 70, 213, 218, 236, 241, 320, 341–343, 345, 351, 357, 377, 380, 400, 430, 847, 1005, 1026, 1880, 1907, and 2059.

94 (BNL-12810) SOLUTIONS OF HALOGENS IN MOLTEN HALIDES. Van Norman, John D.; Tivers, Richard J. (Brookhaven National Lab., Upton, N. Y.). Aug. 1968. 20p. (CONF-680918-3). Dep. CFSTI.

From American Chemical Society Meeting, Atlantic City, N. J.

The solubility of chlorine in molten lead chloride, silver chloride, and the lithium chloride–potassium chloride eutectic and the solubility of bromine in molten lead bromide and lithium bromide were determined. It was found that chlorine becomes more soluble in molten chlorides as the temperature increases while the reverse is true for bromine in molten bromides. Thus, the heats of solution for the chlorine–chloride systems are positive while those of the bromine–bromide systems are negative. The solubilities of bromine in the molten bromides are an order of magnitude greater than those of the chlorine–chloride system. An impermeable vitreous carbon electrode was successfully used for chronopotentiometric measurements on the chlorine–chloride systems. The diffusion coefficients so determined are an order of magnitude larger than those generally associated with ions in molten salts. (auth)

95 (BNWL-SA-1866) CARBOTHERMIC SYNTHESIS OF A MIXED URANIUM–PLUTONIUM NITRIDE. Greenhalgh, W. O.; Weber, E. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 12p. (CONF-680918-1). Dep. CFSTI.

From American Chemical Society Meeting, Atlantic City, N. J.

The synthesis of a solid-solution uranium-plutonium nitride from a mixture of uranium dioxide, plutonium dioxide, and carbon in an atmosphere of nitrogen is described. The general reaction $0.80\ UO_2 + 0.20\ PuO_2 + 2\ C(s) + \frac{1}{2}\ N_2(g) \rightarrow (U_{0.80}Pu_{0.20})N + 2CO(g)$ was carried out at 1600°C with a brief test of completeness at 1700°C. Carbon was added in slight excess to increase the ratio of conversion and, following synthesis, steps were taken to remove the excess. The carbothermic reaction was carried out in a particle-bed reactor under a continuous and constant nitrogen flowrate. Kinetics for the reaction under synthesis conditions were followed by monitoring the reaction offgas for carbon monoxide. Rate constants at several temperatures between 1430 and 1625°C were determined. Total reaction time for a 50 gram batch was about 4 to 5 hours with approximately 99.6% of the oxide being reduced. (auth)

96 (CEA-R-3430) CONTRIBUTION TO THE STUDY OF AN ELECTRODEPOSITION TECHNIQUE FOR PLUTONIUM. Bataller, Georges; Sapy, Claude . (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar. 1968. 26p. (In French). Dep.

An electrodeposition method for plutonium derived from that developed by SANDERS was studied with an improved apparatus. After an optimization of the various parameters, a study was carried out of the fluctuations in the electrodeposition yield according to the method used for separating the plutonium. (auth)

97 (K-1761) ELECTRODEPOSITION OF THORIUM, NEPTUNIUM, AND TECHNETIUM. Petit, G. S.; Griffin, J. D.; Kienberger, C. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Oct. 17, 1968. Contract W-7405-eng-26. 20p. Dep. CFSTI.

Electrodeposition methods have been developed for applying very thin films of thorium oxide, neptunium oxide, and technetium metal on metal surfaces. Recovery of these materials from solution ranges from 96 to 100%. The adherent uniform films range in thickness from 0.0037 to 0.8 mg/cm². The materials are deposited from an ammonium oxalate or ammonium acetate solution with current densities ranging from 200 to 400 ma/cm². Thorium oxide and technetium metal have been deposited on several hundred disks; neptunium oxide has been deposited on several thousand. (auth)

98 (K-L-6221) ADSORPTION OF URANIUM HEXAFLUORIDE ON FIXED BEDS OF SODIUM FLUORIDE. Anderson, L. W. (Oak Ridge Gaseous Diffusion Plant, Tenn.). Sept. 19, 1968. Contract W-7405-eng-26. 11p. Dep. CFSTI.

Fixed-bed adsorption tests were completed that further define the adsorption behavior of the UF_6–NaF system. Results are presented to establish a better understanding of the dependence of the adsorption behavior on various physical parameters, such as temperature, total gas flow rate, and pellet properties. The effect of repeated adsorption–description cycles on the physical structure of NaF pellets is also presented. (M.C.G.)

99 (ORNL-4272, pp 219-20) SPECTROPHOTOMETRIC STUDIES OF SOLUTIONS OF ALPHA-ACTIVE MATERIALS. (Oak Ridge National Lab., Tenn.).

Spectrophotometric techniques for studying aqueous solutions, especially of the lanthanides, actinides, and transition elements are being developed and exploited. A special spectrophotometer system has been built to provide containment for alpha-active materials and to operate at temperatures up to 372°C and pressures up to 10,000 psi. Other studies include correlations of the

spectra of penta- and hexavalent Np, Pu, and Am with those of the uranyl ion and investigations of the emission spectra of some transuranium oxides. (P.C.H.)

100 (ORNL-4272, pp 238-42) PREPARATION AND PROPERTIES OF ACTINIDE OXIDES. (Oak Ridge National Lab., Tenn.).

Electrophoretic studies of sols of UO_2 and various lanthanide hydroxide sols were made. Results indicated that chloride-stabilized UO_2 sols oxidize more slowly than nitrate-stabilized sols and that the U(VI) formed by oxidation is not uniformly distributed among the sol particles. In other studies, correlations were found between different techniques of measuring the charge on sol particles; also, the pH at the isoelectric point for lanthanide hydroxide sols decreased as the atomic number of the metal increased. Aging these sols at 80°C for 2 to 4 weeks can cause a reversal of the sign of the particle charge. (auth)

101 (ORNL-4272, pp 243-8) CHEMISTRY OF CARBIDES AND NITRIDES. (Oak Ridge National Lab., Tenn.).

Fundamental studies of the reactions of the uranium and thorium carbides, nitrides, and carbonitrides with aqueous solutions were continued. In reactions of the uranium carbides with 2 to 18 M NaOH, some of the U in the carbides was oxidized to a higher valence state, with the accompanying evolution of hydrogen. UN reacted with 0.5 to 15.8 M HNO_3, giving gaseous mixtures of N_2, N_2O, and NO_2 (when the acid concentration was 6 M or higher). In reactions of ThC with 0.1 to 1 M HNO_3 at 90°C, both hydrolysis (yielding mainly methane) and oxidation (yielding CO_2 and nitrogen oxides) of the carbide occurred. The main products from the reaction of UN or ThC with 4 and 6 M NH_4F at 80°C were (U or Th)$F_4 \cdot NH_4F$, ammonia, and methane. Uranium carbonitride ($UC_{0.23}N_{0.77}$) was inert at 80°C in water and in 6 M HCl and 6 M NaOH. The carbonitride reacted with 6 M HCl and 6 M H_2SO_4 at 80°C, producing primarily CH_4, NH^{4+}, H_2, and U^{4+}, and, in the case of 6 M H_2SO_4, $U(SO_4)_2 \cdot 4H_2O$. In reactions of the carbonitride with 1 to 8 M HNO_3, the nitride nitrogen was first converted to NH_4^+ and then slowly oxidized to free N_2. (auth)

102 (ORNL-4306) CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 20, 1968. Moore, G. E. (ed.) (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 190p. Dep. CFSTI.

Nine sections are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 103–106, 217, 218, 366, 1879, and 1880.

103 (ORNL-4306, pp 73-105) CHEMISTRY OF AQUEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: a two-structure model for electrolytic solutions; electromotive force measurements in HCl–NaCl, HCl–KCl, HCl–RbCl, HCl–CsCl, HCl–$MgCl_2$, HCl–$CaCl_2$, HCl–$SrCl_2$, HCl–$BaCl_2$, HCl–$AlCl_3$, HCl–$LaCl_3$, and HCl–$GdCl_3$ mixtures; free energies of electrolyte mixtures; physical chemistry of polyelectrolyte systems; salt-induced structure transitions in aqueous solution; hyperfiltration with dynamically formed membranes; activity coefficients of salts in aqueous solutions of pyridine and pyridinium salts; electrolysis of flowing streams with screen electrodes; and diffusion. (P.C.H.)

104 (ORNL-4306, pp 106-19) ELECTROCHEMICAL KINETICS AND ITS APPLICATION TO CORROSION. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: inorganic inhibitors of corrosion; electrochemical behavior of Ti; kinetics of initiation of crevice corrosion; effects of hydrogen ion concentration on the corrosion rate of passive Ti; analysis for the chlorine ion in saline solutions; determination of kinetic constants from chronopotentiograms; influence of inert electrolytes on chronopotentiometric constants; and chronopotentiometry in flowing streams. (P.C.H.)

105 (ORNL-4306, pp 120-30) NONAQUEOUS SYSTEMS AT HIGH TEMPERATURE. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: molten salt–metal solutions, including EMF measurements in molten rare earth metal–metal halide solutions, solubility of thorium metal in molten lithium fluoride–thorium tetrafluoride mixtures, and metal–metal fluoride miscibility; high-temperature thermochemistry, including heat contents of $NaBF_4$, $NaBF_4$–NaF (92–8 mole %), and LiF–BeF_2–ThF_4 (72–16–12 mole %), nonideality of mixing in potassium fluoroborate–sodium (or potassium) fluoride systems, heat content of lanthanide bromides and iodides, and pretransition behavior of solid potassium and thallium sulfate; and high-temperature crystal chemistry, including high-temperature crystal structures of some $M(RX_4)$ compounds. (P.C.H.)

106 (ORNL-4306, pp 131-73) CHEMICAL PHYSICS. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: effects of temperature on the near-infrared absorption spectra of molecules in the condensed states; calorimetry, including attempt to prepare anhydrous $H_3Re_3Cl_{12}$, enthalpy of hydrolysis of rhenium trichloride and enthalpy and free energy of formation of rhenium sesquioxide; microwave and radio-frequency spectroscopy, including paramagnetic resonance study of gamma irradiated single crystals of formic acid; paramagnetic resonance study of aliphatic nitroanion radicals in photolyzed solutions, and paramagnetic resonance of free radicals formed in amides and an imide; neutron and x-ray crystallography, including an air to the analysis of interionic and intermolecular forces in crystals, addition of higher cumulants to the crystallographic structure-factor equation, segmented-body analysis of thermal motion, sorting, scaling, and averaging program for crystal diffraction data, further refinement of the crystal structure of 6-mercaptopurine monohydrate, crystal structure of isoboldine hydrobromide, molecular structure of glycolic acid, crystal and molecular structure of rhenium iron carbonyl, crystal structure of two stereoisomeric photodimers of isophorone, and x-ray diffraction studies of liquids; molecular beam studies, including vibrational excitation and fragmentation of molecular hydrogen from potassium ionic and atomic collisions, crossed-molecular-beam studies of reactions of atomic deuterium with halogen molecules, and crossed-molecular beam studies of bimolecular association and unimolecular decomposition reactions; and uses of electron spectroscopy in chemical problems. (P.C.H.)

107 (RFP-1221) OBSERVATIONS ON THE EFFECT OF SELECTED ORGANIC MATERIALS ON THE USABLE POTENTIAL RANGES OF THE GLASSY CARBON, PYROLYTIC GRAPHITE, AND PLATINUM ELECTRODES. Plock, Carl E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 26, 1968. Contract AT(29-1)-1106. 2p. CFSTI.

The effect of several organic materials on the usable potential ranges of the glassy carbon, pyrolytic graphite, and platinum wire electrodes is reported. (auth)

108 (UCRL-Trans-10266) PMR SPECTRA OF RARE-EARTH COMPLEXES. Burkert, P. L.; Fritz, H. P.; Gretner, W.; Keller, H. J.; Schwarzhans, K. W. Translated by W. E. Jones for Univ. of California, Lawrence Radiation Lab., Livermore, from Inorg. Nucl. Chem. Lett., 4: 31-2(1968). 4p. Dep. CFSTI.

PMR spectra of some complexes of rare earths with ligands such as benzoylacetone and dibenzoylmethane were recorded. Shifts and line widths for the piperidinium salts of $[PrL_4]^-$ and $[DyL_4]^-$ are tabulated. It was concluded from studies on the compound [Pr benzoylacetone)$_4$] that the strong shift of the NH_2 protons of the piperidinium cation to higher fields is due to the dominance of a dipole-dipole interaction component in the shifts. (J.G.B.)

109 RADIOTRACER STUDIES ON THE EXTRACTION OF METAL IONS. XIII. THE DETERMINATION OF DISTRIBUTION COEFFICIENTS AND STABILITY CONSTANTS OF CHELATES OF Ni^{2+} AND UO_2^{2+} WITH SOME SCHIFF BASES. Zielinski, Andrzej; Stronski, Ignacy (Inst. of Nuclear Physics, Krakow). Nukleonika, 13: 765-73(1968).

Bis(3-methoxysalicylaldehyde)propylenediimine and 3-methoxysalicylaldehydeaminophenol were prepared, their electronic spectra were measured, and the pH dependence of distribution coefficients D of Ni^{2+} and UO_2^{2+} ions was determined, applying the radiotracer method. The stability constants $p\beta$ of nickel and uranium chelates were determined by means of the Dyrssen and Sillen two-parameter approximation. (auth)

110 HETEROGENEOUS ISOTOPIC EXCHANGE BETWEEN THE ATOM OF A METAL IN THE PRECIPITATE OF ITS SALT AND THE METAL ION IN THE SOLUTION. Szymanski, Wojciech (Univ., Torun, Poland). Nukleonika, 13: 897-910(1968). (In Polish).

The kinetics of heterogeneous isotopic exchange were investigated in the systems: $AgCN_{(s)}$—Ag^+, $Mn(CN)_{2(s)}$—CN^-, $Co_2FeCN_{6(s)}$—Co^{2+}, $Mn_2FeCN_{6(s)}$—Mn^{2+}. As a result of measurements performed at different temperatures, activation energies of the exchange reaction in the cobaltous and manganous ferrocyanide systems were calculated. On the basis of former and present data it is concluded that in the atom of the metal in the precipitate of its salt and metal ion in the solution systems the isotopic exchange occurs almost exclusively in the surface layer of the precipitate. (auth)

111 ISOTOPE SHIFT STUDIES OF THE ULTRA-VIOLET AND VISIBLE BANDS OF $P^{16}O$ AND $P^{18}O$. Dixit, M. N.; Narasimham, N. A. (Bhabha Atomic Research Centre, Trombay, India). Proc. Indian Acad. Sci., Sect. A, 68: 1-12(July 1968).

The spectra of $P^{16}O$ and $P^{18}O$ were excited in sealed discharge tubes containing neon, oxygen enriched to 65% ^{18}O, and trace amounts of phosphorus vapor. Isotope shift studies in the β-bands confirmed the earlier vibrational scheme of Curry et al., and showed conclusively that the red as well as the violet degraded bands belonged to the same β-system. The present studies of isotope shifts also confirmed the vibrational assignments of the extensive ultraviolet bands involving the $^2\Sigma^- - X^2\Pi$ transition and the γ-bands ($A^2\Sigma^+ - X^2\Pi$). In the case of the visible bands, they provided evidence for the first time that the bands at 5585, 5962, and 6385 Å belonged to one system and involved 0 to 0, 0 to 1, and 0 to 2 transitions, respectively. (auth)

112 ELECTRIC CONDUCTIVITIES OF FUSED UCl_3 AND NaCl–UCl_3 SYSTEMS. Mochinaga, Junichi; Cho, Kangjo (Tokyo Inst. of Tech.). Denki Kagaku, 36: 746-8(Oct. 1968). (In Japanese).

Electric conductivities of UCl_3 melt and fused $NaCl-UCl_3$ salt mixtures were measured using a 1000 Hz ac bridge. The following empirical expression of the specific conductivity of the UCl_3 melt as a function of temperature was obtained: $\kappa = 0.953 + 1.53 \times 10^{-3}(t - 850)$ for $870 < t < 950$°C, where t = temperature (°C), and κ = specific conductivity ($ohm^{-1}\ cm^{-1}$). The results of specific conductivity measurements of $NaCl-UCl_3$ binary salt mixtures showed that at lower concentrations than the eutectic composition, a maximum appeared on the specific conductivity vs temperature curve above 850°C. (NSA of Japan)

113 KINETICS AND MECHANISM OF THE URANIUM(IV)–URANIUM(VI) ELECTRON EXCHANGE REACTION IN HYDROCHLORIC ACID. Tomiyasu, Hiroshi; Fukutomi, Hiroshi; Kakihana, Hidetake (Tokyo Inst. of Tech.). J. Inorg. Nucl. Chem., 30: 2501-11(Sept. 1968).

The rate of the electron exchange reaction between U(IV) and U(VI) was studied in high concentrations of hydrochloric acid and was found to be accelerated by large concentrations of chloride ion. From the rates at different temperatures, ranging from 30 to 70°C, an activation energy and entropy of 32.2 kcal/mole and 25.5 eu, respectively, were calculated. Possible mechanisms consistent with the observed rate law are proposed. (auth) (UK)

114 EFFECT OF ADDED ELECTRON DONOR AND ACCEPTOR ON THE SOLID-STATE EXCHANGE IN $^{57}Co^{2+}$-DOPED TRIS-DIPYRIDYL Co(III) PERCHLORATE TRIHYDRATE. Khorana, S.; Nath, Amar (Bhabha Atomic Research Centre, Trombay, India). pp 141-4 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Considerable isotopic exchange was reported earlier in $Co(dipy)_3(ClO_4)_3\ 3H_2O$ labeled with radiocobalt and it was postulated that electrons play a prominent role in this process. To test this hypothesis, the labeled complex was doped with the electron donor Fe^{2+} and electron acceptors Fe^{3+} and inactive Co^{2+}. It was found that Fe^{2+} enhanced the exchange rate while Fe^{3+} and inactive Co^{2+} decreased the isotopic exchange. This is in harmony with the variable depth electron trapping isotopic exchange model proposed earlier. (auth)

115 THE CO-PRECIPITATION OF Cm^{+3} AND Cf^{+3} WITH $BaSO_4$ AND THE PLUS TWO STATE OF CALIFORNIUM. Fried, S.; Cohen, D. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 4: 611-15(Oct. 1968).

Earlier studies on the reduction of Cf^{3+} by Eu^{3+} indicated that when solvent extraction techniques were used no reduction was found, whereas sulfate coprecipitation techniques indicated reduction by Eu^{2+}. In an attempt to reconcile these contradictory results a study of the coprecipitation behavior of Cm^{3+} and Cf^{3+} was undertaken. $BaSO_4$ was chosen as the carrying agent since it is isomorphous with $EuSO_4$, but has no reducing properties. The effects of acidity and amount of carrier, and the influence of one actinide on the coprecipitation of the other, were examined. It was found that Cm^{3+} and Cf^{3+} were carried in a manner determined largely by the H^+ concentration and the amount of carrier. Substantial percentages of both Cm^{3+} and Cf^{3+}, either individually or in a mixture, were coprecipitated on $BaSO_4$. Experiments were conducted to preclude the possibility that some peculiar difference exists between $EuSO_4$ and $BaSO_4$ in regard to Cm^{3+}. It is concluded that while the results do not preclude the existence of Cf^{2+} in solution, such an influence based on the coprecipitation behavior of scavenging precipitants such as $BaSO_4$ and $EuSO_4$ is unjustified. The earlier solvent extraction experiments were repeated. It was found that the Cf was extracted virtually 100% into the organic phase, indicating that it was not reduced by Eu^{2+}; Cm extraction was ~60%. These figures are in agreement with the K_d's for both trivalent Cm and Cf under the experimental conditions. The Eu was not extracted, indicating that it was not in the Eu^{2+} state. It is concluded that Cf^{2+} was not formed by reduction with Eu^{2+}. (UK)

116 INFRARED SPECTROMETRIC STUDY OF METHYLPHOSPHONIC AND α-AMINOETHYLPHOSPHONIC ACIDS. Dupuy, Bernard; Garrigou-Lagrange, Chantal (Institut de Magneto-Chimie, Pessac, France). J. Chim. Phys., 65: 632-7(Apr. 1968). (In French).

An interpretation of the infrared spectra of α-aminoethylphosphonic acid is proposed for the 4,000 to 200 cm^{-1} region; the spectra have been compared with those of methylphosphonic acid, its mono and disodic derivatives, and their O deuteriated homologs and also with those precedently obtained on DL α-alanine. (auth)

117 AMERICIUM(III)–SULPHATE COMPLEXES. Nair, G. M. (Bhabha Atomic Research Centre, Trombay, India). pp 405-10 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The nature and stability of the complexes formed by americium(III) with sulfate ions in Na_2SO_4 and H_2SO_4 media at an ionic strength of unity at 27°C were determined using a cation exchange technique. Stability constants for the complexes were calculated from the distribution coefficient data for americium(III) by least squares analysis. Anion exchange and electrical migration experiments were carried out in order to establish the nature of the higher complexes formed in the experimental solutions. The discrepancy in the stability constant values for the same species in different media at the same ionic strength is discussed. (auth)

118 PEROXY COMPLEXES OF PLUTONIUM(IV) IN PERCHLORIC ACID. Ghosh Mazumdar, A. S.; Natarajan, P. R.; Vaidyanathan, S. (Bhabha Atomic Research Centre, Trombay, India). pp 411-21 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The formation of red and brown peroxy complexes was studied as a function of plutonium(IV) concentration and of molar ratio of hydrogen peroxide to plutonium(IV). At a molar ratio of hydrogen peroxide to plutonium(IV) equal to 0.4, only the brown complex was formed, the extent of formation decreasing with decrease in plutonium(IV) concentration. At higher molar ratios the red peroxy complex was also formed along with the brown complex, the proportion of red peroxy complex increasing with increase in the molar ratio. The rate of decomposition of the brown peroxy complex of plutonium(IV) in perchloric acid was found to be directly proportional to the hydrogen ion concentration between 0.9 and 2.0M at a constant ionic strength of 2.0 at 28°C keeping the plutonium(IV) concentration at 6.9×10^{-3}M and the molar ratio at 0.4. The Arrhenius activation energy of the reaction was found to be 22.0 ± 3.0 kcals/mole from experiments at 25 to 36°C and the thermodynamic quantities of activation at 28°C were calculated. (auth)

119 STUDIES ON THE DISPROPORTIONATION OF PLUTONIUM(V) IN OXALATE MEDIUM. Ghosh Mazumdar, A. S.; Khandelwal, S. C.; Natarajan, P. R. (Bhabha Atomic Research Centre, Trombay, India). pp 422-35 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The disproportionation of plutonium(V) in oxalate–perchlorate medium was studied at pH = 2.0 to 5.5. A method for the estimation of plutonium(V) in oxalate solutions was developed. The rate and extent of disproportionation were found to increase with decrease in pH and with increase in oxalate concentrations. The rate is proportional to the square of the plutonium(V) concentration. (auth)

120 ISOTOPE EFFECTS IN OXIDATION WITH CHROMIC ACID. PART I. POTENTIOMETRIC AND CONDUCTOMETRIC STUDIES IN WATER AND DEUTERIUM OXIDE. Anantakrishnan, Sekharipuram V.; Sathyabhama, V. (Madras Christian Coll.). pp 444-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The redox potential of the system chromic acid–hexaaquochromium nitrate at a constant ionic strength and acidity maintained with nitric acid was measured at various concentrations of the two compounds at 40°C. To simplify the conditions, the two compounds were kept at the same molalities. A pronounced concentration dependence was noticed both in D_2O and in H_2O. Consistently the redox potentials were lower in D_2O and the potentials were more susceptible to changes in chromic acid concentration

than to the Cr(III) concentration. Conductivity measurements in water and in D_2O were carried out with chromic acid, potassium dichromate, and potassium chromate. The limiting conductances showed that the influence was least in the chromate and a maximum isotope effect was noticed with the chromic acid. Limiting conductances were invariably lower in D_2O. To facilitate the interpretation of these observations and for examining the rate measurements, the absorption spectra of these compounds were studied in water and in heavy water. Chromic acid and potassium dichromate exhibited a common band which was attributed to $HCrO_4^-$ and $DCrO_4^-$. The position of the absorption maximum is an indication that the chromate ion is absent in these two solutions. A tentative interpretation of these results is presented. (auth)

121 ISOTOPE EFFECTS IN CHROMIC ACID OXIDATIONS. PART II. OXIDATION OF ALDEHYDES IN ACETIC ACID–WATER AND ACETIC ACID–DEUTERIUM OXIDE SYSTEMS. Anantakrishnan, Sekharipuram V.; Sathyabhama, V. (Madras Christian Coll.). pp 449-53 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Kinetic studies on the oxidations with chromic acid in acetic acid–water and acetic acid–D_2O were made with acetaldehyde, propionaldehyde, and heptaldehyde. Rates of oxidation in the D_2O mixtures were distinctly slower, with the ratio k_{H_2O}/k_{D_2O} being consistently in the region 1.5 to 2.1. In both cases the reaction is faster in the mixture containing a larger proportion of water. The ratio tended to increase with temperature. The constancy and similarity in trend of the Arrhenius parameters indicate a similarity in mechanism in the solvent mixtures. The results obtained are interpreted in the light of redox potential data and the nature of the electron transfer process. (auth)

122 HEATS OF FORMATION OF SOME URANIUM TETRACHLORIDE TETRAKISALCOHOLS AT 25°C. Thakur, L. (Bhagalpur Univ., India). pp 454-7 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Anhydrous uranium tetrachloride reacts vigorously with methyl, ethyl, and isopropyl alcohols to give crystalline molecular addition compounds of the general formula, UCl_4, 4ROH (R-Me, Et, Pr^i). The heats of solutions of uranium tetrachloride in methyl, ethyl, and isopropyl alcohols and th.. of uranium tetrachloride tetrakisalcohols in their parent alcohols are reported. The standard heats of formations ΔH_f^0 of uranium tetrachloride tetrakisalcohols were calculated. The values for $UCl_4 \cdot 4MeOH$, $UCl_4 \cdot 4EtOH$, and $UCl_4 \cdot 4Pr^iOH$ are −509.8 kcal/mole, −544.6 kcal/mole, and −586.1 kcal/mole, respectively. (auth)

123 ISOTOPE EXCHANGE REACTION BETWEEN IODIDE AND IODATE IONS. PART III. IN FUSED ALKALI NITRATE MEDIA. Arnikar, H. J.; Pansare, R. M. (Univ. of Poona). pp 458-65 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The technique developed for studying isotope exchange reactions by paper chromatography was extended to the exchange reaction between iodide and iodate ions in fused alkali nitrate medium (45.5 $NaNO_3$ + 54.5 KNO_3). Results are reported for the two reacting ions over the temperature range of 250 to 425°C. The first order rate constant for the exchange in the fused salt medium, where solvation effects are negligible, appears to be about 10 to 50 times smaller than the corresponding rate constant in aqueous media over a similar temperature range reported earlier. A modified mechanism is proposed for the exchange under these conditions. (auth)

124 COMPLEX EQUILIBRIA OF UO_2^{2+} WITH LIGANDS HAVING OXYGEN AND NITROGEN DONOR ATOMS. Vartak, D. G.; Menon, N. C. (Bhabha Atomic Research Centre, Trombay, India). pp 466-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The complex equilibria existing in solutions of uranyl ion with organic reagents having O, N donor atoms such as o-amino phenol and its substituted derivatives are examined in aqueous–dioxan medium containing 50% dioxan by volume and 0.1 M $NaClO_4$ with concentrations of metal ion 10^{-3}M and reagent 10^{-2}M. Bjerreum's equations were applied to the systems for the evaluation of metal ligand and proton ligand stability constants. The relation between the pk values and the first metal ligand stability constants is discussed. (auth)

125 INFRARED INVESTIGATIONS ON SOME URANIUM(IV) COMPOUNDS. Sahoo, B. (Indian Inst. of Tech., Kharagpur); Satapathy, K. C. pp 469-72 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The infrared absorption spectra were observed for a number of uranium(IV) compounds with the interest to find the possible existence of oxouranium(IV) entity, UO^{2+}. The compounds examined are formates, acetates, and oxalates of uranium(IV), crystallized with water and in the anhydrous state. Although chemical formulation of a large number of solid uranium(IV) compounds have implied the presence of UO^{2+} ion, infrared absorption spectra in the present studies do not strongly favor such a formulation, because of the absence of a strong sharp band in the characteristic metal–oxygen multiple band region, ca. 850 to 1060 cm^{-1}. But despite the complexity of the spectra, medium to weak bands at 910 to 960 cm^{-1} were observed in almost all the compounds examined. As at present, when there is no other definite assignment to be attributed to these bands, the possibility of the presence of UO^{2+} ion cannot be completely ruled out. It is likely, one of these bands might arise from an infra-f shell magnetic dipole transition for which a value of 915 cm^{-1} has been suggested by Satten and coworkers in UCl_6 ion. One or two medium to strong bands in each of the compounds were observed in the region, ca. 715 to 760 cm^{-1}. These bands are most probably due to stretching vibrations of a unit O–U–O in a chain or polymeric ring structures (O–U–O–U–O) and are of order greater than one but less than two. (auth)

126 REACTIONS OF ACETYL CHLORIDE WITH THORIUM ALKOXIDES. Mehrotra, R. C.; Misra, R. A. (Univ. of Rajasthan, Jaipur, India). pp 473-82 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Th $(OR)_4$ where R = $C_3H_7^i$, $C_4H_9^t$, were studied. Stepwise replacement of isopropoxy groups by chloride radicals in these reactions yielded new compounds: $ThCl(OC_3H_7^i)_3$, $ThCl_2(OC_3H_7^i)_2 \cdot 0.5CH_3COOC_3H_7^i$, $ThCl_3(OC_3H_7^i) \cdot Ch_3COOC_3H_7^i$ and $ThCl_4 \cdot 2CH_3COOC_3H_7^i$. The reactions of acetyl chloride with thorium tertiary butoxide were studied in detail. The replacement of the first tertiary butoxide group appeared to be slow, but with further replacement, side reactions occurred resulting in the formation of acetate derivatives. Corroboration of the above conclusion was furnished by studying the reactions between thorium tetrachloride and tertiary butyl acetate in different molar ratios. (auth)

127 INVESTIGATION OF THE COMPLEXING OF TRIVALENT LANTHANIDE AND ACTINIDE ELEMENTS WITH ETHYLENEDIAMINE-BIS-ISOPROPYLPHOSPHONIC ACID BY THE ELECTROMIGRATION METHOD. Lebedev, I. A.; Shalinets, A. B. Radiokhimiya, 10: 233-8 (Mar.-Apr. 1968). (In Russian).

The formation of complexes of trivalent Am, Cm, and Pm with ethylenediamine-bis-isopropylphosphonic acid was investigated at ion strength of 0.1 (KNO_3) and t = 25 ± 0.1°C by electromigration on porous packing. Complex ions of the type MH_3A^{2+}, MH_2A^+, MHA^0, and MA^- were identified and their stability constants were determined. (tr-auth)

128 OXIDATION STUDIES. V. OXIDATION OF LIGHT AND HEAVY WATER BY PEROXYDISULPHATE. Padma, S.; Santappa, M. (Univ. of Madras). Proc. Indian Acad. Sci., Sect. A, 68: 47-52(July 1968).

Oxidation of light and heavy water by peroxydisulfate was studied at 60 to 70°C. The acid independent and acid dependent rate constants and respective ΔE values were computed. An attempt is made to explain the observed kinetic isotopic effect. A probable mechanism is proposed. (auth)

129 PLASTIC SCINTILLATION MATERIALS. (to Rohm and Haas GmbH). British Patent 1,128,140. Sept. 25, 1968. Priority date July 16, 1964, Germany.

A plastic scintillation material is prepared by copolymerizing p-vinyltoluene and methyl methacrylate in a ratio of 1:1 to 1:4 by weight in an essentially oxygen-free atmosphere and dispersing at least one scintillator substance in this polymer. The scintillation substance may be 2-phenyl-5-(4-biphenylyl)-1,3,4,-oxadiazole or 2,2'-p-phenylene-bis(5-phenyloxazole). (B.L.M.)

130 FORMATION, THERMAL DECOMPOSITION, AND STRUCTURE OF THE SYSTEM UO_3–H_2O. III. THERMAL DECOMPOSITION OF β–$UO_3 \cdot 2H_2O$ PRODUCED FROM γ–UO_3. Poko, Z.; Fodor, M.; Szabo, E. (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 57: 275-89 (1968).

The properties of the system UO_3-H_2O were studied by the analysis of the thermal decomposition of uranium trioxide hydration products of different origins. The results obtained on the system, γ-UO_3-H_2O, and in particular observations concerning the thermal decomposition of the $\beta-UO_3\cdot 2H_2O$-type dihydrate, produced from γ-UO_3, are reported. The derivatographic results show the difference between γ-UO_3 and the other uranium oxide hydration products. The distinct properties of the α- and β-type dihydrates became apparent from an analysis of the thermal behavior of the UO_3 hydrolysis products obtained at room temperature. (auth)

131 DISTRIBUTION OF THENOYLTRIFLUOROACETONE AND ITS SCANDIUM CHELATE IN KETONE SOLVENT SYSTEM. Wakabayashi, Toshiki; Takaizumi, Katsuko; Seto, Kunio; Suzuki, Nobuo; Akiba, Ken-ichi (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 41: 1854-8(Aug. 1968).

The distribution equilibria of thenoyltrifluoroacetone (TTA) and its scandium chelate between aqueous solutions with an ionic strength of 0.1 and ketones at 25°C were studied. The distribution of TTA was correlated with the solubility parameters of the ketones and the correlation between the distribution coefficients of TTA and those of scandium chelate was confirmed. The characteristic properties of ketones were discussed in comparison with those of other oxygen containing solvents. (auth)

132 VIBRATIONAL SPECTROSCOPIC STUDY OF $(R-PO_3)^{2-}$. Nyquist, Richard A. (Dow Chemical Co., Midland, Mich.). J. Mol. Struct., 2: 123-35(Aug. 1968).

Infrared and Raman data for sodium methylphosphonate, $CH_3-PO_3Na_2$, and the CD_3^- analog were obtained. These data were interpreted to show that $(CH_3-PO_3)^{2-}$ in aqueous solution has C_{3v} symmetry, and in the solid phase perhaps has C_{3v} site symmetry. Comparison of the ir solid-phase data for $CH_3-PO_3Na_2$ with the ir solid-phase data for $CH_3-PO_3K_2$ suggests that a band at low frequency results from a crystalline lattice vibration. Suggested correlations of ir bands for the general ion $(R-PO_3)^{2-}$ are also given. (auth)

133 SURFACE REACTION FOR HETEROGENEOUS ISOTOPIC EXCHANGE IN THE SYSTEM $CH_3{}^*I_{gas}/NaI_{solid}$. Lieser, K. H.; Joerchel, E. (Technische Hochschule, Darmstadt, Ger.). Z. Phys. Chem. (Frankfurt), 59: 324-5(June 1968). (In German).

The heterogeneous isotopic exchange between solid NaI and gaseous ^{131}I-labeled CH_3I was investigated in the temperature range between 177 and 255°C. The results showed that the exchange first occurs over 150°C with measurable velocity. If the surface, determined by the BET method is taken as a reference value, then at 177°C only one atomic layer participates in the surface reaction. With increasing temperature the number of atomic layers participating in the surface reaction increases. At 225°C about 30 atomic layers take part in the fast exchange reaction. A first order equation describing the reaction is given. (J.S.R.)

134 ELECTRICAL CONDUCTIVITY OF SILICA GEL IN THE PRESENCE OF ADSORBED WATER. Anderson, J. H.; Parks, G. A. (Stanford Univ., Calif.). J. Phys. Chem., 72: 3662-8(Oct. 1968).

Experiments were performed to determine the mechanism of surface electrical conduction of silica gel and the influence of adsorbed water and surface hydroxyl groups on surface conductivity. Several similarities between the electrical properties of aqueous electrolytes and silica gel surfaces with water adsorbed were found. This suggests the conduction mechanism is ionic. The magnitude of the change of conductivity when H_2O is replaced by D_2O suggests that the charge carriers are protons. Simultaneous determination of resistivity and the near-infrared spectra of adsorbed water and surface hydroxyl groups was used to explore the relationship between resistivity and the concentrations of adsorbed species. Resistivity was found to decrease exponentially with water content and increase roughly exponentially with OH content. A protonic model of surface conduction is presented which is based on the assertion that mobile protons arise from the dissociation of surface hydroxyl groups or adsorbed water molecules. Dissociation and, therefore, conductivity are enhanced by adsorption of polar molecules which increase the dielectric constant of the silica gel, thereby reducing the dissociation energy for protons. This model is consistent with the effects of surface hydroxyl concentration, concentration of adsorbed molecules, and the relationship between the dipole moment of the adsorbed molecule and conductivity. (auth)

135 MEASUREMENT OF VAPOR-PRESSURE DIFFERENCES FOR ISOTOPIC COMPOUNDS. Wolff, H.; Hoepfner, A. (Univ., Heidelberg). Angew. Chem. Int. Ed. Engl., 6: 713-14 (Aug. 1967).

Replacement of H by D either decreases (normal effect) or increases (inverse effect) the vapor pressure (p) of a substance. Hydrocarbons show the inverse effect; alcohols and amines (including H_2O and NH_3) show a normal effect after replacement is at the hydroxyl or amino group, but otherwise an inverse effect. Study of the vapor-pressure isotope effect for the methylamines CH_3NH_2 (1), CH_3ND_2 (2), CD_3NH_2 (3), and CH_3ND_2 (4) in relation to temperature and concentration (in mixtures with n-hexane) showed strong, temperature-dependent normal effects for the pairs (1)/(2) and (3)/(4), that changed to inverse effects at high dilution (molar fraction <0.1). The inverse effects observed for (1)/(3) and (2)/(4) were only slightly dependent on temperature and independent of concentration. It was concluded that appearance of the normal vapor-pressure isotope effect for these substances is connected with the occurrence of association by H bonding. Quantitative interpretation was made in terms of the H-bond vibrations to which the translational and rotational degrees of freedom of the free molecule correspond, though these vibrations are not readily accessible spectroscopically. (BBB)

136 HYDROGEN ISOTOPE FRACTIONATION BETWEEN THE SOLVENT AND HYDROGEN IONS IN METHANOL SOLUTION. Gold, V.; Grist, S. (King's Coll., London). Chem. Commun., No. 20, 1216-17(1968).

NMR methods have been applied to the direct measurement of parameter l, expressing deuterium fractionation between the aqueous hydrogen ion and water, and a key quantity in the formulation of expressions for rate and equilibrium constants in H_2O-D_2O systems. The magnitude of the chemical shift due to anions present in an aqueous solution of a strong mineral acid was uncertain, however. Present studies were made with HCl in dry methanol, and in methanol-^2H, in which solvent it is possible to evaluate anion shifts separately. The molal shift of the methanolic hydrogen ion was calculated as -0.827 ppM. All shifts were measured relative to the methyl resonance. It was assumed that shifts were only slightly changed by isotopic change of the solvent. It was found that $l[=(D:H)MeOL_2/(D:H)_{MeOL}]$ was 0.60. The fractionation was greater than in the case of the aqueous hydrogen ion, which is perhaps a reflection of the more acidic character of the methanolic hydrogen ion. It is assumed that HCl in methanol solution is ionized, though not necessarily fully dissociated. Results were applied to a preliminary analysis of kinetic measurements of hydrogen ion catalysis in methanol, and the value for l was found reasonable. (UK)

137 IMPLICATION OF SMALL HYDROGEN–DEUTERIUM KINETIC ISOTOPE EFFECT IN THE REACTION OF QUINALDINE AND 1-METHYLISOQUINOLINE N-OXIDES WITH ACETIC ANHYDRIDE. Tamagaki, S.; Kozuka, S.; Oae, S. (Osaka City Univ.). Tetrahedron Lett., No. 46, 4765-8(Sept. 1968).

It was found that, unlike other α-alkylated pyridine and quinoline N-oxides, reactions of quinaldine and 1-methylisoquinoline N-oxides with acetic anhydride show a rather small kinetic isotope effect (1.5 and 3.5, respectively). The reaction of 6-methylquinaldine N-oxide, on the other hand, showed a kinetic isotope effect of normal magnitude (7.4), indicating the rate determining step to be proton removal. Possible reasons for the former small isotope effects are discussed. (UK)

138 URANIUM–TRANSITION METAL SILICIDES OF THE AB_2X_2 COMPOSITION. Ban, Z.; Sikirica, M. (Univ. of Zagreb. Rudjer Boskovic Inst., Zagreb). Z. Anorg. Allg. Chem., 356: 96-104(1967).

The existence of a new series of compounds was established in the system U–M–Si (M = Mn, Fe, Co, Ni, and Cu). They are isostructural with the previously reported ThM_2Si_2 and ThM_2Ge_2 compounds (space group I 4/mmm with Z = 2). The variable parameter z defining the position of silicon atoms was determined by computing the electron density distribution along the c-axis. Analysis of the principal structure parameters of some of these isostructural ternary phases indicates that small irregularities can be explained in terms of odd or even number of electrons present in the A and/or M atoms. (auth)

139 METHOD FOR THE CALCULATION OF STABILITY CONSTANTS OF COMPLEXES FROM ULTRASONIC VELOCITY MEASUREMENTS. Laxmi, Shobhay; Prakash, Som; Prakash, Satya (Allahabad Univ., India). Indian J. Chem., 6: 31-3(Jan. 1968).

A method for the determination of stability constant of complexes is proposed based on ultrasonic velocity and adiabatic compressibility lowering data. These two parameters decrease with the addition of the metal ions to the ligand solution, reach a minimum value at the stoichiometric ratio, and then increase continuously. Thus the position of the minimum indicates the point of maximum complex formation. The method, which consists of determining the

composition of solutions having identical values of the compressibility lowering, has been tested for ethylenediaminetetraacetic acid (EDTA) chelates of Sr^{2+}, Zn^{2+}, and Cd^{2+}. The values agree fairly well with those obtained by potentiometric method. (auth)

140 THERMOGRAVIMETRIC ANALYSIS AND GAS CHROMATOGRAPHY OF RARE EARTH CHELATES OF TRIFLUOROACETYLPIVALOYLMETHANE. Tanaka, M.; Shono, T.; Shinra, K. (Osaka Univ.). Anal. Chim. Acta, 43: No. 1, 157-8(Oct. 1968).

Eleven chelates of the ligand trifluoroacetylpivaloylmethane [1,1,1-trifluoro-5,5-dimethyl-2,4-hexanedione H(TAPM)] with tripositive rare earth metal ions were synthesized. All the complexes obtained were monohydrates, which could be easily dehydrated in vacuo over P_2O_5. Thermogravimetric curves were constructed for the anhydrous TAPM chelates. It was found that TAPM chelates volatilized at quite low temperatures without decomposition and can be chromatographed in the vapor phase. A plot of the retention time vs the ionic radius of the corresponding six-coordinate, tripositive metal ion showed that the retention time tends to decrease with decreasing ionic radius. (D.H.M.)

141 METHOD FOR PRODUCING 2-(2-METHYL-3-HYDROXY-5-PHOSPHORYLHYDROXYMETHYL-4-PYRIDYL)-TETRAHYDRO-1,3-THIAZINE-4-CARBOXYLIC ACID. Okumura, Kentaro (to Tanabe Seiyaku Co., Ltd.). Japanese Patent 1968-714, Jan. 11, 1968. Filed Oct. 11, 1965.

The condensation reaction between pyridoxal-5'-phosphoric ester and homocystine produces 2-(2-methyl-3-hydroxy-5-phosphorylhydroxymethyl-4-pyridyl)-tetrahydro-1,3-thiazine-4-carboxylic acid, which is useful in medicine to heal the liver, to mitigate fatigue, to protect against radiation, etc. (NSA of Japan)

142 PREPARATION AND STRUCTURAL STUDIES OF PHOSPHATES WITH COMMON FORMULA $M^{I}M_2^{IV}(PO_4)_3$ (M^{I} = Li, Na, K, Rb, Cs; M^{IV} = Th, U, Zr, Hf). Matkovic, B.; Prodic, B.; Sljukic, M. (Institute Rudjer Boskovic, Zagreb. Univ., Sarajevo, Yugoslavia). Bull. Soc. Chim. Fr., 1777-9(1968).

Methods are described for the preparation of alkali metal salts of Th, U(IV), Zr, and Hf phosphates. The crystallographic data of Th and U(IV) compounds support the assumption that the atomic arrangement is the same as that for $KTh_2(PO_4)_3$. The symmetry of the R3c space group gives the possibility of coordination nine for Zr or Hf atoms, because the trigonal prism with additional ligands outside each of the rectangular faces retains the three-fold axis. No similarity was found between the corresponding members of alkali metal salts of Zr (or Hf) phosphates and alkali metal salts of Th (or U(IV)) phosphates in the crystallographic properties and in the coordination polyhedron. Data are tabulated. (P.C.H.)

143 NEW COMPOUND OF GERMANIUM AND URANIUM. Legros, Jean-Pierre; Masdupuy, Emile (Faculte des Sciences, Toulouse). Compt. Rend., Ser. C, 267: 307-9(July 22, 1968). (In French).

A new compound of germanium and uranium was prepared by the action of uranyl acetate on an aqueous solution of germanium dioxide. It appears that the formula is that of a uranyl acid orthogermanate, $(UO_2OH)_2H_2GeO_4$. (tr-auth)

144 INTERNATIONAL CONFERENCE ON SOLID MINERAL PHOSPHATES, TOULOUSE, FRANCE, MAY 16–20, 1967. Bull. Soc. Chim. Fr., 1657-1847(1968). (In several languages). (CONF-670549).

Forty-four papers are included; a separate abstract was prepared for one. The remaining 43 papers include information on preparation and properties of phosphates; structure of phosphates; and effects of trace elements on properties of phosphates; luminescent phosphates; phosphate catalyzers; and ion exchange phosphates. (P.C.H.)

For abstract of individual paper see: 142.

145 STUDY OF THE SYSTEM URANYL NITRATE–SODIUM SALT OF 3-(5-CHLORO-2-HYDROXYPHENYLAZO)-4,5-DIHYDROXYNAPHTHALENE-2,7-DISULFONIC ACID. Spacu, P.; Mavrodin, Maria. Rev. Roum. Chim., 13: 775-9(June 1968). (In Rumanian).

The reaction between uranyl nitrate and the sodium salt of 3-[(5-chloro-2-hydroxyphenyl)azo]-4,5-dihydroxy-2,7-naphthalene disulfonic acid was studied by means of spectrophotometric methods and with the aid of ion exchangers. The study indicated that in the system there is formed a compound characterized by the relation UO_2^{2+}: R = 1:2, the dissociation constant K = 7.4 × 10^{-12}, and the molar extinction coefficient, 19,059. (tr-auth)

146 COMPLEX FORMATION BETWEEN URANYL(VI) AND THIOPROPIONIC ACID. Mishra, M. B.; Nigam, H. L. (Univ. of Allahabad, India). Acta Chim. Acad. Sci. Hung., 57: 1-4(1968).

Potentiometric studies in solution revealed the formation of a 1:2 metal:ligand [UO_2(VI):TPA] complex (where TPA stands for thiopropionic acid). The stepwise stability constants are log K_1 = 3.7 and log K_2 = 7.4, and the corresponding free energy of formation is −5.13 cal. (at 30°C). The complex was isolated as a yellow solid which shows the same composition as in solution. It was characterized by infrared and magnetic measurements. (auth)

147 CORRELATIONS BETWEEN MOLECULAR STRUCTURE AND MASS SPECTRA. PART II. THE MASS SPECTROMETRIC FRAGMENTATION BEHAVIOR OF ISOPENTYL CYANIDE AND ITS DEUTERIUM ANALOGUES. Rol, N. C. (Koninklijke/Shell-Laboratorium, Amsterdam). Rec. Trav. Chim., 87: 321-34(Apr. 1968).

Fragmentation of the isopentyl cyanide ion was investigated by means of D labeling and precision mass measurements. Comparisons with the reactions postulated to account for the mass spectra of cyanides, especially those of isohexyl cyanide and its D analogues, revealed unexpected features. The mass spectra of isohexyl cyanide and isopentyl cyanide are tabulated. Further, the 2,2-d_2 and 3,3-d_2 analogues of isopentyl nitrile were synthesized and their spectra recorded, for the study of abnormal rearrangement reactions. In the McLafferty rearrangement the probability ratio of γ- to δ-H transfer is about 24 to 30:1 to give $C_2H_5N^+$ ions, strengthening earlier doubts regarding the exclusive validity of the concept of γ-H transfer. Isotope effects were judged to be small, but not insignificant. In (P-1)-ion formation it is mainly the γ-H that is lost, possibly with a 5-ring ion being formed. (BBB)

148 ACID-BASE REACTIONS AND HYDROGEN EXCHANGE IN FUSED ACETATE EUTECTICS. THE DECOMPOSITION OF TRIMETHYLOLETHANE. Burton, Louis L.; Crowell, Thomas I. (Univ. of Virginia, Charlottesville). J. Amer. Chem. Soc., 90: 5940-1(Oct. 9, 1968).

Some phenomena observed in the ternary eutectic, lithium acetate–potassium acetate–sodium acetate (32–30–38 mol%, mp 162°C) are reported. Phenolic indicators such as alizarin, alizarin yellow, p-nitrophenol, and m-nitrophenol ionize to give the colors of their conjugate bases. The less acidic aromatic amine indicators differ in degree of dissociation, depending on the substituent. Exchange of the hydrogen atoms in the methyl group takes place in K^+, Na^+–OAc^- eutectic (54–46 mol%) to the extent of 40% in 10 hr at 250°C. When dissolved in the ternary eutectic at 200°C, trimethylolethane and trimethylolpropane decompose to the same products observed when the molten triols are heated at 240 to 260°C with alumina. Trimethylolethane reacted quantitatively, with a rate constant 3.5×10^{-5} sec^{-1} after a 40 min induction period. Deuterium-labeled trimethylolethane was used to try and determine the mechanisms involved in the reaction. (D.H.M.)

149 ISOTOPIC EXCHANGE OF ACETOXYL GROUPS IN PENTA-O-ACETYL-α AND β-D-GALACTOFURANOSES. Swiderski, Jan; Strucinski, Jerzy (Univ. of Warsaw). Rocz. Chem., 42: 1295-7(1968). (In Polish).

An isotopic exchange between anhydrous acetic acid labeled with ^{14}C in the carboxyl group and penta-O-acetyl-α and β-D-galactofuranoses was stated. In the course of the isotopic exchange the specific rotation of acetylgalactose remains unchanged. Penta-O-acetyl-α and β-D-galactopyranoses exhibit a much higher radioactivity than penta-O-acetyl-α and β-D-galactofuranoses. It was demonstrated that the pyranose ring influences importantly the mobility of the acetoxyl groups. (auth)

150 HYDROGEN ISOTOPIC EXCHANGE IN FIVE MEMBERED AROMATIC HETEROCYCLES. I. BENZAZOLES AND ITS 2-METHYL DERIVATIVES. Zatsepina, N. N.; Kaminskii, Yu. L.; Tupitsin, I. F. (State Inst. of Applied Chemistry, Leningrad). Reakts. Sposobnost Org. Soedin., Tartu. Gos. Univ., 4: 433-44(Sept. 1967). (In Russian).

The kinetic of hydrogen isotopic exchange in benzazoles and its 2-methyl derivatives have been studied in ethanol-d_1 and 0.57 N ethanolic potassium ethoxide. Some peculiarities of heteroatom influence on the acidity of aromatic and aliphatic C–H–bonds are elucidated. The presence of lgK-σ^- linear relationship for the isotopic exchange in ethanolic ethoxide solution reflects a significant role of the resonance interaction in activation of methyl groups. Deuterium exchange of benzazoles and its 2-methyl derivatives in pure ethanol is complicated with the pyridine-like nitrogen protonation. Monotonous decreasing of exchange rate constants in the series benzoxazole, benzoselenazole, benzothiazole indicates d-orbital effects to be unessential in the reaction studied. The differences in measured values of the kinetic

isotopic effects when aliphatic and aromatic C–H–bond is exchanged, are considered to be indicative of limited stage alteration (C–H–bond ionisation in the first instance and solvent molecule diffusion from reaction zone in the second one). (auth)

151 MECHANISM OF REACTIONS OF α-DIAZOSULFONES. III. FURTHER STUDY OF THE ACID-CATALYSED HYDROLYSIS OF ARYL- AND ALKYLSULFONYLDIAZOMETHANES. Engberts, J. B. F. N.; Swanenburg, B. (Univ., Groningen, Netherlands). Tetrahedron, 24: 1737-54(Feb. 1968).

The mechanism of the acid-catalysed hydrolysis of aryl-, and in particular, alkylsulfonyldiazomethanes was studied in water, 40% (v/v) dioxane–water and 60% (v/v) dioxane–water as the solvents. The reaction is specifically catalyzed by hydronium ions as indicated by the solvent deuterium isotope effect. Strong evidence is presented for carbon protonation as the first step during the hydrolysis. Very fast H–D exchange of the methine proton was observed by PMR spectroscopy in 60% (v/v) dioxane–deuterium oxide solutions of strong acids and bases. In neutral 60% (v/v) dioxane–deutrium oxide solutions the rate constants of exchange could be evaluated. The logarithm of the pseudo first order rate constants of hydrolysis are linear in H_0 for $HClO_4$, HCl, and H_2SO_4 as the catalysts. The slopes of these linear plots increase with increasing nucleophilicity of the conjugate base of the acid. At constant ionic strength the pseudo first order rate constants are linear in the acid concentration. At a constant $HClO_4$ concentration, the salts $NaClO_4$, NaCl, and NaBr showed a positive salt effect which increased with increasing nucleophilicity of the anion. In acidic media containing chloride anions, the rate enhancement as compared with solutions containing the same amount of perchlorate anions, is directly correlated to the percentage of RSO_2CH_2Cl formed. A bimolecular rate determining step adequately accounts for the kinetic data. The activation parameter $\Delta S^{\ddagger}$ is also in the region of an A-2 mechanism. The nucleophilic contribution to the transition state is rather small. The oxibase scale was used to correlate the nucleophilic sensitiveness of several diazonium ions. (auth)

152 POSSIBILITY OF ENERGY TRANSFER THROUGH A HYDROCARBON CHAIN DURING THERMAL DECOMPOSITION OF AN AZO COMPOUND. Mylonakis, Stamatios G.; Seltzer, Stanley (Brookhaven National Lab., Upton, N. Y.). J. Amer. Chem. Soc., 90: 5487-9(Sept. 25, 1968).

The mechanism of the thermal decomposition of a 24-membered ring with two azo groups was studied by kinetics and the secondary α-deuterium isotope effect. A concerted loss of both nitrogen molecules is ruled out on the basis of the isotope effect, $k_H/k_D = 1.20$ (four atoms of D). A crossover experiment indicates that the biradical, formed after the expulsion of the first nitrogen molecule, couples to reclose the ring before the second nitrogen molecule is lost. Because there are eight methylene groups between the two azo groups, it is unlikely that vibrational excitation is transferred between azo groups. Rather, it is probable that the two azo groups act independently. (auth)

153 pH DEPENDENCE OF THE PEPSIN-CATALYZED HYDROLYSIS OF NEUTRAL DIPEPTIDES. Clement, Gerald E.; Snyder, Stephen L.; Price, Howard; Cartmell, Rheta (State Univ. of New York, Binghamton). J. Amer. Chem. Soc., 90: 5603-10 (Sept. 25, 1968).

The pH dependences of the kinetic constants for the pepsin-catalyzed hydrolysis of N-acetyl-L-phenylalanyl-L-tyrosine methyl ester were determined in the pH range 1.05 to 5.05 at 25°C using twice-crystallized pepsin. The pH vs. k_{cat} and K_m figures were bell-shaped curves. The pH vs. k_{cat} curves depend on a pair of catalytic groups with pK_a's in water and deuterium oxide of 1.62, 3.48, and 1.92, 4.01, respectively. For this reaction, there is no deuterium oxide solvent isotope effect with $k_{H_2O\,lim}/k_{D_2O\,lim} = 1.05 \pm 0.30$. The competitive inhibition constant, K_I, for N-acetyl-D-phenylalanyl-D-tyrosine methyl ester was found to be equal to the Michaelis constant, K_m, for the L-L substrate at various pH's between 1.10 and 4.05. This indicates that the K_m measured under turnover conditions is a true equilibrium constant not modified by additional rate constants. The pH dependences of the kinetic constants for the pepsin-catalyzed hydrolyses of N-acetyl-L-phenylalanyl-L-tyrosine methyl ester, N-acetyl-L-phenylalanyl-L-phenylalanine methyl ester, and N-acetyl-L-tyrosyl-L-phenylalanine methyl ester were also determined in this pH range. The pH vs. k_{cat} and k_m profiles were all bell-shaped curves. Evidence is presented that $k_{cat} = k_2$, the first catalytic step of the reaction. Based on these results a mechanism is proposed for these reactions which accounts for the prototropic equilibria and a rate-determining step which does not involve a proton transfer. Finally the inhibition constants for some of the products and dioxane were also determined in this pH range. (auth)

154 BASE-CATALYZED DEUTERIUM EXCHANGE OF ACYCLIC SULFONES. Broaddus, C. D. (Procter and Gamble Co., Cincinnati). J. Amer. Chem. Soc., 90: 5504-11 (Sept. 25, 1968).

A series of alkyl and alkenyl methyl sulfones was subjected to deuterioxide-catalyzed exchange in deuterium oxide–dioxane solvent at 25°C. It was shown that 2-hydroxyhexyl methyl sulfone was stable to these exchange conditions. From these results the following conclusions may be drawn. (1) Increased alkyl substitution at a carbon adjacent to a sulfone substituent strongly retards the rate of carbanion formation relative to similar substitution changes in nitroalkanes and ketones. (2) The rate of exchange of an $-SO_2CH_3$ site is little affected by the other hydrocarbon group attached to sulfone substituent whether it be alkyl, 1-alkenyl, or 2-alkenyl. (3) Alkyl-substituted allyl anionic species generated adjacent to a sulfone group undergo very specific protonation at the site next to the sulfone group. The difference in activation energies for the two protonation reactions is larger than the difference in ground-state energies of 1- and 2-alkenyl methyl sulfones. (4) Replacement of hydrogen on a carbon adjacent to a sulfone group by a 1-pentenyl substituent increases the rate of base-catalyzed deuterium exchange by a factor of ~10. Replacement of n-propyl by 1-pentenyl causes a $\sim 10^4$ increase in rate of exchange. (5) 1-Alkenyl methyl sulfones undergo most rapid exchange at the α-methyl position. The α-vinyl hydrogen is exchanged, by a proton abstraction mechanism, somewhat more rapidly than reaction occurs at the allylic site. (6) Little difference is seen in the reactivities of cis- and trans-1-alkenyl methyl sulfones or in the reactivities of cis- and trans-2-alkenyl methyl sulfones. (auth)

155 EFFECT OF CATION ON THE STEREOCHEMISTRY OF HYDROGEN–DEUTERIUM EXCHANGE. Hunter, D. H.; Lin, Y-T (Univ. of Western Ontario, London). J. Amer. Chem. Soc., 90: 5921-2(Oct. 9, 1968).

An inversion in the stereochemistry of base-catalyzed hydrogen–deuterium exchange dependent only on the nature of the cations present in solution was observed. The rigid system, 1-trideuteriomethoxy-1,2,2-trideuterioacenaphthene, was prepared and the deuterons were exchanged in tert-butyl alcohol. Results show that when tetramethylammonium tert-butoxide is the base, the preferential hydrogen incorporation is trans to the methoxyl group. When potassium tert-butoxide is the base, the opposite behavior with hydrogen incorporation occurring predominantly cis to the methoxyl group. When lithium tert–butoxide is the base, exchange occurred exclusively cis to the methoxyl group. (D.H.M.)

156 ISOTOPIC EXCHANGE AND ELECTROCHEMICAL STUDIES ON THE REDOX SYSTEM $Ph_6Pb_2/Ph_3Pb^{\cdot}$. Doretti, Lucio; Tagliavini, Giuseppe (Univ., Padua). J. Organometal. Chem. (Amsterdam), 13: 195-8(July 1968).

Isotopic exchange between labeled hexaphenyldilead and triphenyllead ions supports the hypothesis of the formation of $Ph_3Pb\cdot$ radicals at the surface of a platinized Pt foil. The lack of isotopic exchange in benzene solution between hexaphenyldilead labeled with radioactive lead and triphenyllead chloride is an earlier argument supporting the argument against chomolytic dissociation. Radioactive hexaphenyldilead was prepared by the same method by using $PbCl_2$ labeled with ^{210}Pb. Solutions of triphenyllead ions and radioactive hexaphenyldilead were prepared mixed and kept at 25°C in the presence or absence of a platinized Pt foil, smooth Pt, or Hg. After a known time the solution was removed and evaporated to dryness without heating. The solid residue was dissolved and triphenyllead ions were precipitated as Ph_3PbF with a saturated aqueous KF solution. The precipitate was filtered off, washed, suspended in methanol, transferred to a disk, and counted with a scalar counter. Only 3 to 4% isotopic exchange was observed when the reactants were mixed in the presence of Hg or smooth Pt, as in the case in homogeneous solution. Intermediate radical species are probably responsible for the observed electrochemical reversibility. The average value of the formal standard potential E_0 is -0.102 ± 0.002 V. (BBB)

157 METHYL-d_3 ISOTOPE EFFECTS AND THE ORIGIN OF α-METHYL SUBSTITUENT EFFECTS. Servis, K. L.; Borcic, S.; Sunko, D. E. (Rudjer Boskovic Inst., Zagreb. Univ. of Southern California, Los Angeles). Tetrahedron, 24: 1247-53 (Feb. 1968).

The kinetic isotope effects on the solvolysis of a series of 1-methyl-d_3-cycloalkyl chlorides was determined. A linear correspondence between α-methylsubstituent effects and methyl-d_3 isotope effects is presented and discussed. (auth)

158 RADIOCHROMATOGRAPHIC STUDIES OF $H_5(PMo_{10}V_2O_{40})$ STABILITY IN AQUEOUS SOLUTIONS. Ripan, R.; Suteu, A. Stud. Univ. Babes-Bolyai, Ser. Chem., 13: No. 1, 117-21(1968). (In Rumanian).

It was demonstrated that the acid $H_5[PMo_{10}V_2O_{40}]$ exhibits maximum stability when the pH = 1. At pH >3.5 the heteropolyacid decomposes, the molybdenum departing from the first of the sphere of the complex, and forming some unsaturated heteropolyanions. At pH 4.5, desegregation of the heteropolyanions begins by separation of the phosphorus atoms of the complex, the decomposition becoming total at pH = 7. The isotopic exchange accomplished with ^{32}P and ^{99}Mo proved that the central atom of P exhibits a slower isotope exchange than the Mo. (tr-auth)

159 RELATIVE CONTRIBUTIONS OF HYPERCONJUGATION AND NONBONDED INTERACTIONS TO SECONDARY ISOTOPE EFFECTS. Sonnichsen, George Carl. East Lansing, Mich., Michigan State Univ., 1967. 75p.

Thesis.

Secondary beta isotope effects in S_N1 reactions were generally attributed to greater hyperconjugative stabilization of the carbonium ion-like transition state by the protium compound. Bartell proposed that these isotope effects may be due to greater relief of nonbonded interactions for the hydrogen compound than the deuterium compound while proceeding from the reactant to the transition state. He also devised a method to calculate the isotope effects originating from nonbonded interactions. In order to ascertain the reliability of Bartell's method of calculation, isotope effects were measured for the solvolysis of compounds where hyperconjugation is not possible, and these isotope effects were compared with the isotope effects calculated for these compounds. The isotope effect for solvolysis of 8-methyl-d_3-1-naphthylcarbinyl chloride in 66.67% acetone-water (V/V) was found to be $k_H/k_D = 1.013 \pm 0.022$ at 25°C. From kinetic measurements at 15 and 35°C it was established that $\Delta H_H^{\ddagger} - \Delta H_D^{\ddagger} = 140 \pm 300$ cal/mole and $\Delta S_H^{\ddagger} - \Delta S_D^{\ddagger} = 0.49 \pm 0.44$ cal/deg/mole. The alpha isotope effect, $k_H/k_D = 1.32$, for the solvolysis of Ic indicates that the mechanism of the reaction is S_N1. In most cases the calculated isotope effects agreed with the experimental ones, thus indicating that Bartell's method can be used to predict the magnitude of isotope effects due to nonbonded interactions. However, the isotope effects that were calculated for systems where hyperconjugation is possible were not in accord with the experimental values. For t-butyl chloride-d_9, acetyl chloride-d_3, and ethyl acetate-d_3 the calculated isotope effects were much less than the experimental ones. Thus it was concluded that in most systems, where hyperconjugation is possible, the major portion of the isotope effect is due to hyperconjugation. (Disser. Abstr.)

160 ABSENCE OF CARBONYL OXYGEN EXCHANGE CONCURRENT WITH THE ALKALINE HYDROLYSIS OF SUBSTITUTED METHYL BENZOATES. Shain, Sydney A.; Kirsch, Jack F. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 90: 5848-54 (Oct. 9, 1968).

The carbonyl ^{18}O content of labeled methyl benzoate, methyl p-nitrobenzoate, methyl p-aminobenzoate, and ethyl benzoate was monitored during the course of alkaline hydrolysis. No ^{18}O depletion was observed for any of the three methyl benzoates for up to 85% completion of reaction in 33.3% dioxane–water. In addition, the incorporation of solvent ^{18}O into methyl p-nitrobenzoate during alkaline hydrolysis in 33.3% dioxane–water employing water enriched in ^{18}O was measured. Although the latter results are complicated by possible exchange of ^{18}O into the p-nitro substituent, a minimum value of 36.4 could be assigned to the ratio k_h/k_{ex}. These results are not in agreement with a previously published report of extensive oxygen exchange concurrent with the alkaline hydrolysis of these compounds under these conditions. Both methyl and ethyl benzoate were observed to exchange carbonyl oxygen with solvent oxygen during the course of alkaline hydrolysis in water in the absence of added dioxane. The values of k_h/k_{ex} were 27.7 and 12.6, respectively. These observations are consistent with the interpretation that the principal determinant of the k_h/k_{ex} ratio is the stability of the departing anion; but other factors including the affinity of the anion for acyl carbon as opposed to the proton and rates of proton transfer within the intermediate must be considered in a quantitative evaluation. (auth)

161 ARYNE PATHWAY IN THE DECOMPOSITION OF DIAZOTIZED 2,5-Di-t-BUTYLANILINE. Franck, Richard W.; Yanagi, Kiyoshi (Fordham Univ., New York). J. Amer. Chem. Soc., 90: 5814-17(Oct. 9, 1968).

An arynoid adduct can be obtained when 2,5-di-tert-butylaniline is diazotized in the presence of furan. In order to decide whether an aryne is an intermediate in the decomposition, experiments were undertaken with aniline-d_2 as substrate. Mass spectral isotope analyses as well as product yields were used as evidence for possible mechanisms. A partitioning isotope effect was detected, with the adduct decreasing in yield with 2,5-di-tert-butylaniline-d_2 as substrate. Apparent reduction of aryne to arene was observed particularly in control experiments when furan was omitted as a trap. A consistent reaction scheme including an aryne is presented. (auth)

162 X-RAY DIFFRACTION STUDIES OF THORIUM(IV) PERCHLORATE AND THORIUM(IV) OXYPERCHLORATE IN AQUEOUS SOLUTION. Bacon, William Edward. Kent, Ohio, Kent State Univ., 1967. 140p.

Thesis.

Aqueous solutions of thorium(IV) perchlorate and thorium(IV) oxyperchlorate were investigated by the x-ray-radial distribution method. The Waser-Schomaker peak shape functions were used to evaluate the areas beneath the radial distribution curves. The thorium(IV) perchlorate solutions were prepared in dilute $HClO_4$ and the thorium(IV) oxyperchlorate solutions in water. Models were proposed for the structural units in solution, and the calculated intensities were compared to the intensities obtained from the experimental data. The radial distribution curve for thorium(IV) perchlorate dissolved in $HClO_4$ showed two peaks, one at 1.50A, and the other at 2.50A. The former peak occurs at a distance corresponding to the Cl–O bond distance in the ClO_4^- and the latter to the Th–O distance. A coordination number of 11 was found for the Th atom. It is proposed that the Th atom surrounded by 4 ClO_4 and 3 molecules of water of hydration is the most probable structural unit in the thorium(IV) perchlorate solution. The calculated intensity from the model compared to the intensities found by experiment is cited as evidence for the structural unit. Thorium(IV) oxyperchlorate was prepared by heating thorium(IV) perchlorate. Investigation of an aqueous solution by x-ray-radial distribution method yields a radial distribution curve with maxima at 1.50A, 2.50A, and 4.00A, respectively. The first two maxima correspond to the Cl–O and Th–O interactions discussed above. The latter maxima corresponds to the Th–Th interactions. This peak indicates the presence of polynuclear compounds, and the area beneath this peak corresponds to a tetrahedral arrangement of Th atoms. The model, $Th_4(OH)_4^{+12}$, is proposed as the most probable structural unit in the thorium(IV) oxyperchlorate solution. The agreement between the calculated intensity from the model and the intensity obtained from experimental determination is cited as evidence for this structural unit in solution. (Disser. Abstr.)

163 ABSORPTIOMETRIC STUDY OF THE CHELATES FORMED BETWEEN THE LANTHANOIDS AND XYLENOL ORANGE. Munshi, Kailash N.; Dey, Arun K. (Univ. of Nagpur, India. Univ. of Allahabad, India). Mikrochim. Acta, No. 5, 1059-65(1968).

The formation of violet colored chelates (λ_{max}= 570 nm) between the lanthanoids and Xylenol Orange (DCAC) at pH 5.5 is reported. Absorbance measurements indicate the composition of all the chelates to be 1:1 and the chelates are stable over pH 4.0 to 7.0. The values of log K for various lanthanoid chelates of DCAC lie in the range of 4.5 to 5.4. The dissociation constants of Xylenol Orange have been evaluated and the position of the chelation has been suggested. (auth)

164 STRUCTURE OF THE NEW COMPOUND $UFeO_4$. Bacmann, M.; Bertaut, E. F. (CNRS, Grenoble, France). Bull. Soc. Fr. Miner. Crist., 90: 257-8(Apr.-June 1967). (In French).

An x-ray study of the compound $UFeO_4$ indicates that it is isomorphic with $UCrO_4$. The cell is orthorhombic; its parameters are $a = 4.88_8$, $b = 11.93_7$, $c = 5.11_0$ Å. The volume is greater than that of $UCrO_4$ by 2.7%. The space group is Pbcn; neutron magnetic diffraction indicates Cr(III) and U(V) in $UCrO_4$. Observed and calculated factors are tabulated; the residual factor is 1.8%. Atomic parameters are grouped. The principal interatomic distances in Å are Fe–Fe, 2.92; Fe–20, 1.99; Fe–20_I, 2.05; Fe–20_{II}, 2.09; U–Fe, 3.29; U–U, 4.08; U–20_I, 2.05; U–20_{II}, 2.18; U–20_{II}, 2.22; shortest O–O, 2.83. The octahedron surrounding Fe is seen to be much more deformed than that around Cr in $UCrO_4$. This observation recalls the deformability of Fe_2O_3 compared to Cr_2O_3. A study of the magnetic properties of the compound is in progress. (BBB)

165 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF URANIUM(VI) WITH N,N'-DI(HYDROXYPHENYL)-C-CYANOFORMAZAN. Sergovskaya, V. V.; Soboleva, T. A. Tr. Ural. Politekh. Inst., 148: 117-23(1966). (In Russian).

A spectrophotometric study was made of the interaction of N,N'-di(hydroxyphenyl)-C-cyanoformazan with U(VI). It was established that in the pH interval from 4 to 10 one complex compound was formed. In acetone–water solution it has a maximum light absorption at 640 to 645 mmk (pH 4 to 8). The molar ratio of the components equals 1:1; the molar absorption coefficient is 13,800. The dissociation constant of the complex compound is 1×10^{-8} (pH 5.7). The color intensity of the solution of the complex obeys Beer's law in the concentration interval from 0.25 to 30 mkg U/ml. The compound formed has a high stability

with respect to Complexon (III). Conditions for using the reagent for the photometric determination of uranium were found; a method was developed for the direct determination of U in the presence of Bi and Th using Complexon (III) for elimination of the interferring effects of these elements. The possibility of the quantitative extraction of the complex obtained with n-butyl alcohol, tributyl phosphate, and their mixtures with different diluents was noted. The capacity of N,N′-di-(2-hydroxyphenyl)-C-cyanoformazan to react with UO_2^{2+} in tributyl phosphate solution was detected. (tr-auth)

166 REACTIONS OF KETEN ACETALS. PART I. THE HYDROLYSIS OF CYANOKETEN DIMETHYL ACETAL: GENERAL ACID CATALYSIS AND KINETIC HYDROGEN ISOTOPE EFFECTS. Gold, V.; Waterman, D. C. A. (King's Coll., London). J. Chem. Soc., B, No. 8, 839-48(1968).

The hydrolysis of cyanoketen dimethyl acetal to methyl cyanoacetate was found to be subject to general acid catalysis. Catalytic coefficients are reported for nine aliphatic acids and the hydrogen ion, the reactivity of which is much smaller than expected from the parameters of the Brønsted catalysis law (G = 100, α = 0.62) established for the aliphatic acids. At high concentrations of buffer solutions, especially for the weaker acids, the rate of the catalysed reaction contribution increases less rapidly than expected from the results at low buffer concentrations. It is suggested that dimerisation of the undissociated acid and association between carboxylic acid and carboxylate anion are responsible for the effect. For acetic acid, the results for both cyanoketen dimethyl acetal and 2-dichloromethylene-1,3-dioxolan are satisfied by K_{ass} = 1.6 l mole^{-1}, K_d = 0.4 l mole^{-1}. General acid catalysis was also studied for three carboxylic acids in deuterium oxide as solvent. The value of the Brønsted exponent α remained virtually unaltered. The rate isotope effects for proton (deuteron) transfer from the carboxylic acids (k_H/k_D) were approximately 5.3. The corresponding isotope effect for the hydrogen ion is approximately 3.0. In mixtures of H_2O and D_2O the velocity of the hydrogen ion-catalysed reaction falls off in accordance with the expression given by Gold (Trans. Faraday Soc., 1960, 56, 255). The best value of α required to fit the data to this equation is in the range 0.5 to 0.65, which straddles the value of the Brønsted exponent for carboxylic acids. The catalytic coefficient of acetic acid decreases practically linearly with the deuterium content of the medium, and it is shown that this result points to the relative unimportance of a 'transfer' or 'medium' isotope effect superimposed on the exchange effect. (auth) (UK)

167 ORGANIC DISULFIDES AND RELATED SUBSTANCES. XXV. THIOCARBAMOYL AND IMIDOCARBAMOYL DISULFIDES. Field, Lamar; Buckman, John D. (Vanderbilt Univ., Nashville). J. Org. Chem., 33: 3865-71(Oct. 1968).

Thiolsulfonates (aryl, primary, or tertiary alkyl) thioalkylated dithiocarbamates (unsubstituted, N-methyl, N,N-dimethyl) to form unsymmetrical thiocarbamoyl disulfides in 48 to 88% yield; a promising synthesis of an ammonium alkanesulfinate resulted as a side issue. Dipotassium N-(p-toluenesulfonyl)dithiocarbamate was dialkylated at sulfur by methyl sulfate but only monothioalkylated by a thiolsulfonate. An imidocarbamoyl disulfide was prepared from a sulfenyl chloride with thiourea under milder conditions than used previously, which minimized disproportionation. Evidence that the products were unsymmetrical disulfides and not mixtures of symmetrical ones included independent synthesis, x-ray diffraction, thin layer chromatography, spectra, solubility properties, and thermal decomposition in solution. In the thermal decompositions, the N,N-dimethyl compounds were the most stable, the N-methyl next, and the unsubstituted least; the first of these disproportionated to symmetrical disulfides, the last underwent elimination (giving a trisulfide, carbon disulfide, and a mixture of ammonium thiocyanate with thiourea), and the N-methyl series did both. Within each class the order of decreasing stability was t-alkyl > primary alkyl > aryl; decomposition was fastest in solvents of highest polarity. Two disulfides were active as antiradiation drugs, and several had other useful biological properties. (auth)

168 RARE-EARTH PREPARATIONS WITH REDUCING PROPERTIES. Silver, Gary L. (Mound Lab., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. J. Inorg. Nucl. Chem., 30: 1735-8(Aug. 1968).

When neodymium metal is placed in warm, dilute acetic acid, a light brown precipitate appears as the metal dissolves. The precipitate exhibits reducing properties, which suggest a lower oxidation state of the neodymium. Similar materials can be prepared with other rare earth metals and other acids. A precipitate obtained when gadolinium metal reacts with mucochloric acid is described. (auth) (UK)

169 REACTION OF NEPTUNIUM HEXAFLUORIDE WITH SODIUM FLUORIDE. Trevorrow, L. E.; Gerding, T. J.; Steindler, M. J. (Argonne National Lab., Ill.). Inorg. Chem., 7: 2226-9(Nov. 1968).

The equation $3NaF(s) + NpF_6(g) \rightleftharpoons 3NaF \cdot NpF_5(s) + \frac{1}{2} F_2(g)$ was found to represent the equilibrium involved in the reaction of neptunium hexafluoride with sodium fluoride at 250 to 400°. The partial pressures of fluorine and neptunium hexafluoride in equilibrium with the solid phase formed by reaction of neptunium hexafluoride with sodium fluoride were obtained by measurements of total pressure and ultraviolet absorbence of the gas phase. At a fixed temperature (350°) over a 10-fold variation of fluorine pressure, the value of log p_{NpF_6} was found to depend linearly on log, p_{F_2} with a proportionality coefficient of 0.49, comparable to the value of ½ expected for the above reaction. Equilibrium constants, $K_p = p_{NpF_6}/p_{F_2}^{\frac{1}{2}}$, for the reaction at 250 to 400°, were expressed by the equation $\log K_p(atm)^{\frac{1}{2}} = [-3{,}147 \times 10^3/T(°K)] + 2.784$. The x-ray powder diffraction pattern obtained for $3NaF \cdot NpF_5$, sodium octafluoroneptunate(V), was indexed on the basis of a body-centered tetragonal unit cell with lattice constants a = 5.449 ± 0.001 and c = 10.853 ± 0.003 Å. (auth)

170 COMPOUNDS OF CALIFORNIUM. Fried, S.; Cohen, D.; Siegel, S.; Tani, B. (Argonne National Lab., Ill.). Inorg. Nucl. Chem. Lett., 4: 495-8(Sept. 1968).

The preparation, on the microgram scale, of $CfBr_3$, CfOBr, CfI_3, CfOI, and Cf_2S_3 is described, employing ^{249}Cf. The technique for "milking" the ^{249}Cf from ^{249}Bk is also described. Powder diffraction patterns indicated that the $CfBr_3$ pattern was not of the characteristic β or orthorhombic modification of which $PuBr_3$ is a prototype, nor of the α-modification (UCl_3 type), and it remains to be determined whether a third structure type is indicated. CfOBr was found to be isostructural with BkOBr (tetragonal; a = 3.90 Å, c = 8.12 Å; PbFCl type). The CfI_3 was isostructural with BkI_3 and of BiI_3 type (hexagonal; a = 7.55 Å, c = 20.8 Å). The CfOI was also of PbFCl type and isostructural with BkOI (tetragonal; a = 3.97 Å, c = 9.14 Å). The Cf_2S_3 was cubic, and of Ce_2S_3 type (a = 8.388 Å). (UK)

171 CRYSTAL STRUCTURE OF THORIUM DIIODIDE. Guggenberger, L. J.; Jacobson, R. A. (E. I. du Pont de Nemours and Co., Wilmington, Del. Iowa State Univ., Ames). Inorg. Chem., 7: 2257-60(Nov. 1968).

The crystal structure of thorium diiodide, ThI_2, has been determined from counter data by single-crystal x-ray techniques. Thorium diiodide crystallizes in space group $P6_3/mmc$ of the hexagonal system with four formula units in a unit cell of dimensions a = 3.97 ± 0.01 and c = 31.75 ± 0.04 Å and with a calculated density of 7.45 g/cm^3. Least-squares refinement of the structure has led to a final value of the conventional R factor of 0.082 for 200 reflections. The structure consists of four two-dimensionally infinite layers alternating between trigonal-antiprismatic and trigonal-prismatic layers. The coordination polyhedra consist of thorium atoms encompassed by trigonal-antiprismatic polyhedra of iodine atoms in the antiprismatic layers and trigonal-prismatic polyhedra of iodine atoms in the prismatic layers. The coordination polyhedra for both types of layers are linked by the sharing of edges. The Th–I bond distances are 3.22 ± 0.01 and 3.20 ± 0.01 Å in the antiprismatic and prismatic layers, respectively. The results are consistent with a prediction by Clark and Corbett that ThI_2 is not a true thorium(II) salt but should be formulated as $Th^{4+}(I^-)_2(e^-)_2$. (auth)

172 TEMPERATURE EFFECT ON WATER AND HEAVY-WATER STRUCTURE IN AQUEOUS ACID SOLUTIONS. Morariu, V. V.; Bucur, R. V. (Inst. for Atomic Physics, Cluj). J. Mol. Struc., 2: 349-51(Nov. 1968).

The variation with temperature (T) of the electrical conduction (λ) of solutions of $HClO_4$, H_2SO_4, H_3PO_4, and CH_3COOH (pH ~ 2.7, 25°) in H_2O and D_2O (~98% mole D) has been measured. The apparent activation energies of protonic conduction (E_a) show a rapid change at about T_t = 28.7° in H_2O and at about T_t = 25.5° in D_2O. The change of the apparent activation energy ΔE_a near T_t was greater in D_2O than in H_2O and decreased for the various anions in the following order: $CH_3COO^- > SO_4^{2-} > PO_4^{3-} > ClO_4^-$. This effect was due to the difference in the structure-changing properties of the anions. The $\Delta E_{D_2O} - \Delta E_{H_2O}$ value for $HClO_4$ and H_2SO_4 solutions was equal to 0.27 kcal mole^{-1}. This difference is attributed to the difference between the energy of hydrogen bonding in D_2O and H_2O. (auth)

173 CARBON DEPOSITION ON NICKEL–URANIUM–ALPHA-ALUMINA CATALYSTS. Nicklin, Thomas. Gas-Wasserfach, 109: 329-34(Mar. 29, 1968). (In German).

Two aspects of the influence of U on the C obtained during the gasification reaction are described: the influence of U on the equilibrium between CO, CO_2, and C, and the influence of U on

the reaction of catalyst with C in air to produce catalyst and gas. The catalyst studied had Ni, 15.8%; U, 10.7%; K, 0.15%. A reference without U was also employed. When CO was passed over this catalyst equilibrium was reached at the following temperatures at the given times to produce the percent CO in the final mixture given: 350°C, 24 hr, 39%; 400°C, 20 hr, 44%; 500°C, 15 hr, 59%; 600°C, 9 hr, 72%; 700°C, 5 hr, 85%. From these data, equilibrium constants and thermodynamic data for the reactions are derived. The log k_p for the formation of CO_2 and C from CO is considerably lowered by the addition of U, particularly at low temperatures: log k_p with U at 350°C, 0.8; without U at 350°C, 3.6; with U at 750°C, −0.8; without U at 750°C, −0.3. The activation energy for the second process was determined as a function of % U (% Ni = 5.5%, constant) by 2 methods. Kissinger's method gave 28 kcal/mole at 0% to 12 kcal/mole at 9%; Borchardt and Daniels' method gave 22 kcal/mole at 0% to 8 kcal/mole at 9%. This creates a problem in the interpretation of the influence of U on the mechanism of the combustion of C on the catalyst. (BBB)

174 INVESTIGATION OF CIS- AND TRANS-EFFECT IN PLATINUM COORDINATED COMPOUNDS BY THE ISOTOPIC EXCHANGE METHOD. Grinberg, A. A.; Kukushkin, Yu. N.; Kuz'mina, M. A.; V'yugina, A. F. (Radium Inst., Leningrad). Izv. Sib. Otd. Akad. Nauk SSSR, No. 7, Ser. Khim. Nauk, No. 3, 131-6(May 1968). (In Russian).

The rate of isotopic exchange of chlorine in the following systems: $K[PtNH_3Cl_3]$ + KCl, $K[PtPyCl_3]$ + KCl, $K[PtC_2H_4Cl_3]$ + KCl, and $K[PtC_2H_4Br]$ + KBr was investigated. The exchange proceeds via aquation. The possibility of the transmission of trans-effect of ligands through two atoms is discussed for the case of $[Pt(NH_3)_4ClNH_2]^{2+}$ and $[Pt(NH_3)_4ClNH_2]^{2+}$. The cis- and trans-effect series are presented. (auth)

175 SPECTRA OF URANYL NITRATE ADDUCTS WITH ORGANOPHOSPHORUS AND ORGANONITROGEN LIGANDS. Siddall III, T. H.; McDonald, R. L.; Stewart, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). J. Mol. Spectrosc., 28: 243-64(Oct. 1968).

The near visible absorption and emission spectra (spectrophotometric) and infrared spectra were obtained for adducts of uranyl nitrate with a large variety of organophosphorus and organonitrogen ligands, with the object of providing a rationale for the spectra of these uranyl compounds. Adducts without a symmetry center show enhanced absorption in the near visible as compared to the absorption for adducts with a symmetry center. This enhancement is observed both for solid mulls and for solutions. The spectra for adducts without a symmetry center are very similar to and are classified with those obtained for inorganic double nitrates, while the spectra for adducts with a symmetry center are classified with that of simple uranyl nitrate. The origins of the progressions in the near visible are discussed. It is proposed that the enhanced absorption has something in common with hypersensitivity in rare-earth spectra. It was concluded, however, that no entirely satisfactory rationale, including the one developed in this work, has yet been provided for the near visible spectra of uranyl compounds. The near visible absorption spectra cannot be rationalized in terms of a singlet–triplet transition, but must involve some more complicated group of transitions. (auth)

176 REACTIONS OF KETEN ACETALS. PART II. THE HYDROLYSIS OF 2-(DICHLOROMETHYLENE)-1,3-DIOXOLANE: GENERAL ACID CATALYSIS AND RATE AND PROTECTION HYDROGEN ISOTOPE EFFECTS. Gold, V.; Waterman, D. C. A. (Kings Coll., London). J. Chem. Soc., B, No. 8, 849-55(1968).

The acid-catalyzed formation of 2-hydroxyethyl dichloroacetate from 2-(dichloromethylene)-1,3-dioxolane (DMD) showed the same general kinetic features as the hydrolysis of cyanoketen dimethyl acetal. The parameters of the Broensted catalysis law for both protio- and deuterio-acids and the effects of changing the deuterium content of the medium on the reaction catalyzed by acetic acid and by hydrogen ion were established. The results can be interpreted on the same lines as the corresponding results for cyanoketen dimethyl acetal and support the conclusions reached from the study of that compound (see Journ. Chem. Soc., B, No. 8, 839(1968)). In addition it is possible to study in this case the isotopic composition of the product of the hydrogen ion-catalyzed reaction in H_2O-D_2O mixtures. Taken in conjunction with measurements of the isotopic rate ratio (k_H/k_D), the results permit an evaluation of the transfer contribution to the solvent isotope effect. It was concluded that this effect must be small relative to the exchange effect for reactions of this type. The problem whether it is correct to assume that the Broensted exponent is a quantitative measure of the degree of proton transfer in the transition state is discussed with reference to the finding that the rate isotope effect (k_H/k_D) for the present reaction is less that that for the hydrolysis of cyanoketen dimethyl acetal, despite the fact that the Broensted exponent for DMD is almost exactly one-half. (auth) (UK)

177 HYDROGEN ISOTOPE DISPROPORTIONATION IN WATER AND ITS EFFECT ON ISOTOPE-EXCHANGE EQUILIBRIUM CONSTANTS MEASURED IN AQUEOUS SOLUTION. Kresge, A. J.; Chiang, Y. (Illinois Inst. of Tech., Chicago). Contract AT(11-1)-1025. J. Chem. Phys., 49: 1439-40(Aug. 1, 1968).

The equilibrium constant for the disproportionation reaction $H_2O + D_2O \rightarrow 2HDO$ was found to be 3.76 ± 0.02. This value is significantly different from the value of 4.00 provided by symmetry numbers of product and reactants. In order to investigate the effect of this difference on the fractionation factor in an exchange system, the fractionation factor for 1,3,5-trimethyoxybenzene dissolved in water was determined at three different solvent D-atom fractions. The results showed a trend which, though bordering on the precision of the method, was in the expected direction. The method is ideally suited to use with systems using substrates containing only one exchangeable H. (B.L.M.)

178 NEUTRON-DIFFRACTION STUDY OF THE CRYSTALLINE STRUCTURE OF U_2F_9. Laveissiere, J. (Centre d'Etudes Nucleaires, Gif-sur-Yvette, France). Bull. Soc. Fr. Miner. Crist., 90: 308-10(July-Sept. 1967). (In French).

The crystal structure of body-centered U_2F_9 was refined. The space group is I43m, the lattice constant is a = 8.4716 ± 0.0005 Å and the average U-F distance is 2.30 Å. The neutron diffraction spectrum at room temperature is illustrated, and the intensities obtained by x-ray diffraction and by neutron diffraction are compared graphically. Position parameters are U, x = 0.1888; F_I, x = 0.2276; F_{II}, x = 0.2059, z = 0.4419. A table of calculated and observed intensities is given. Interatomic distances to greater accuracy are (in Å): U−U, 4.483; U−F_I, 2.285; U−F_{II}, 2.155, 2.442; F_I-F_I, 2.727; F_I-F_{II}, 2.601, 3.062; $F_{II}-F_{II}$, 2.668, 2.827. Relative errors range from 0.003 to 0.014 Å. (BBB)

179 ^{13}C KINETIC ISOTOPE EFFECT IN THE THERMAL ISOMERIZATION OF METHYL ISOCYANIDE. Wettaw, John F.; Sims, L. B. (Michigan State Univ., East Lansing). J. Phys. Chem., 72: 3440-4(Oct. 1968).

The average ^{13}C kinetic isotope effect in the thermal unimolecular isomerization of methyl isocyanide to acetonitrile was investigated from 1 atm to 1 cm at 226°C. At high pressures the average ^{13}C isotope effect, r, is given by $r_\infty = 0.998 \exp[(21 \pm 6)/RT]$. At lower pressures the effect declines as expected for unimolecular reactions; at 226°C the values of r at 1 atm and 1 cm are 1.018 and 1.011, respectively. The observed average isotope effect, r, is related to the individual kinetic isotope effects r_1 and r_2 (arising from labeling the methyl and isonitrile carbon positions, respectively). r_1 and r_2 were calculated from the Marcus version of the Rice–Rampsberger, Kassel theory (RRKM) for various models of activated complex. Good agreement with experiment was obtained with a ring structure complex model similar to that used by Rabinovitch and coworkers for the interpretation of the isomerization rate constant falloff and the deuterium kinetic isotope effect; the present results substantiate the proposed mechanism. (auth)

180 CORRELATION BETWEEN THE STEREOCHEMISTRY OF QUINOLIZIDINE ALKALOIDS AND THEIR INFRARED SPECTRA FROM 2840 TO 2600 CM^{-1}. Skolik, J. (Univ. of Calgary, Alberta, Can.); Krueger, P. J.; Wiewiorowski, M. Tetrahedron, 24: 5439-56(Aug. 1968).

The ir spectra from 2840 to 2600 cm^{-1} of a number of sparteine type quinolizidine alkaloids and their selectively α-deuterated derivatives were examined. It was shown that a single absorption band or band complex arises from the stretching vibrations of one or more axially oriented $C_\alpha-H$ bonds. The intensity and general complexity of this absorption is roughly proportional to the number of these trans-diaxial α hydrogens and their steric environment. The characteristic absorption in the 2840 to 2600 cm^{-1} region has been correlated with different conformations of quinolizidine ring fusions. Steric factors influencing this absorption in sparteine type alkaloids are discussed. An attempt was made to rationalize the nature of the specific interaction of $C_\alpha-H(a)$ bonds with the line electron pair on nitrogen in the compounds investigated. (auth)

181 KINETIC DEUTERIUM ISOTOPE EFFECT IN THE REACTION OF METHYL IODIDE WITH CYANIDE ION IN AQUEOUS SOLUTION FROM 0 TO 40°. Willi, Alfred V.; Won, Chong Min (Columbia Univ., New York). J. Amer. Chem. Soc., 90: 5999-6001(Oct. 23, 1968).

The kinetic α-deuterium isotope effect, k_H/k_D, was measured for the reaction of $CH_3I(CD_3I)$ with CN^- in aqueous solution from

0 to 40°. Kinetic measurements were carried out in reaction vessels with no gas phase. Results indicate an inverse isotope effect: $k_H/k_D = 0.926$ (25°), with the Arrhenius parameters $A_H/A_D = 1.124$ (±0.005), $E_{aH} - E_{aD} = 116$ (±20) cal. The experimental data are compared with results of model calculations of isotope effects from force constants with an electronic computer. Reasonable choices of some of the transition-state force constants can be made by comparison with suitable stable molecules. The bending force constant, f_{HCC}, is adjusted to give the best fit with the experimental isotope effect. It is planned to compare this f_{HCC} value with bending force constants for other transition states belonging to related reactions. It is found that excellent agreement between experimental and calculated Arrhenius parameters of the isotope effect may be obtained if 5.05 rather than 5.3 mdyn/Å is used for the CH stretching force constant, f_{CH}, of the transition state. (auth)

182 HYDROGEN–DEUTERIUM KINETIC ISOTOPE EFFECTS IN THE GAS PHASE BROMINATION OF MONODEUTERATED TOLUENE. Timmons, Richard B.; de Guzman, Jose; Varnerin, Robert E. (Catholic Univ. of America, Washington, D. C.). J. Amer. Chem. Soc., 90: 5996-8(Oct. 23, 1968).

The intramolecular hydrogen–deuterium kinetic isotope effect in the gas phase bromination of monodeuterated toluene was determined. The ratio of second-order rate constants obtained over the temperature interval of 120 to 160° can be expressed in terms of the following equation: $k_H/k_D = (1.08 \pm 0.25) \exp(1430 \pm 110)/RT$. The kinetic isotope effect measured in these gas phase experiments is larger than the corresponding values reported in solution studies. A general discussion of the comparison of the solution and gas phase results is presented. (auth)

183 INTERACTION OF THORIUM(IV) WITH HYDROXYETHYLETHYLENEDIAMINETRIACETIC ACID AND OTHER LIGANDS IN AQUEOUS SOLUTION. Bogucki, R. F.; Martell, A. E. (Clark Univ., Worcester, Mass. Purdue Univ., Lafayette, Ind. Texas A and M Univ., College Station). Contracts AT(30-1)-1823; AT(40-1)-3621. J. Amer. Chem. Soc., 90: 6022-7 (Oct. 23, 1968). (ORO-3621-1).

Potentiometric equilibrium measurements of hydrogen ion concentration were employed to investigate the interaction of the Th (IV) ion with N-hydroxyethylethylenediaminetriacetic acid (HEDTA) and with the related ligands nitrilotriacetic acid (NTA), N-hydroxyethyliminodiacetic acid (HIMDA), N-methyliminodiacetic acid (MIMDA), oxybis(ethylenenitrilo)tetraacetic acid (OETA), and ethylenebis(oxyethylenenitrilo)tetraacetic acid (EOTA). Evidence is presented for hydrolysis reactions of the Th(IV) chelates of all these ligands as the pH is increased. Mononuclear monohydroxo species are formed from 1:1 chelates of OETA and EOTA and with the 2:1 chelate of NTA. Fractional neutralization values in the potentiometric titration curves of the 1:1 HEDTA chelate and the 2:1 HIMDA chelate indicate the formation of hydrolyzed polynuclear chelates containing three or some multiple of three Th(IV) ions. The formation constant of the 1:1 Th(IV)–HEDTA chelate was determined to be $10^{18.5}$ from spectrometric measurement of equilibrium competition between Cu(II) and Th(IV) for the ligand. Equilibrium constants are also reported for the formation of the hydroxo mononuclear Th(IV)–HEDTA chelate, the binuclear μ-dihydroxo Th(IV)–HEDTA chelate, the mononuclear hydroxo 1:1 chelates of OETA and EOTA, and the mononuclear hydroxy 1:2 Th(IV)–NTA chelate. Possible arrangements of ligand donor groups and metal ions in the ternuclear and hexanuclear Th(IV)–HECTA chelate species are inferred, and the possible involvement of the hydroxyethyl group as a bridging ligand is suggested. (auth)

184 STUDY OF THE CRYSTALLINE TRANSFORMATIONS SHOWN AT HIGH TEMPERATURE BY THE COMPOUND $LaYbO_3$. Traverse, Jean-Pierre; Coutures, Juliette; Foex, Marc (Centre National de la Recherche Scientifique, Montlouis, France). Compt. Rend., Ser. C, 267: 391-4(July 29, 1968). (In French).

The compound $LaYbO_3$, with orthorhombic structure at room temperature, presents two crystalline forms at high temperature. The variety stable in the vicinity of the melting point has a cubic centered structure resembling the high-temperature form of certain sesquioxides of lanthanides (La_2O_3 to Gd_2O_3). (tr-auth)

185 HYDRATED DOUBLE SULPHATES AND CHLORIDES OF TERVALENT URANIUM. Barnard, R.; Bullock, J. I.; Larkworthy, L. F. (Univ. of Surrey, London). Chem. Commun., No. 16, 960-1(1968).

$U_2(SO_4)_3 \cdot 8H_2O$ was converted into the olive-green double sulphates $(NH_4)_2SO_4 \cdot U_2(SO_4)_3 \cdot 9H_2O$, $Na_2SO_4 \cdot U_2(SO_4)_3 \cdot 4H_2O$, $3K_2SO_4 \cdot U_2(SO_4)_3$, $Rb_2SO_4 \cdot U_2(SO_4)_3 \cdot 8H_2O$, and $Cs_2SO_4 \cdot U_2(SO_4)_3 \cdot 11H_2O$, which gave purple–red solutions in conc. HCl. By handling the cold solutions under N_2 crystalline purple compounds $M^1UCl_4 \cdot 5H_2O$ (M = K, Rb, NH_4) were obtained. The Na and Cs solutions decomposed before any U(III) compounds could be isolated. Reflectance spectra, infrared spectra, and magnetic moments are discussed. (UK)

186 INVESTIGATION OF THE PROCESS OF THE FORMATION, COMPOSITION, AND THERMAL STABILITY OF THE SELENITES OF SOME RARE EARTH ELEMENTS AND YTTRIUM. Savchenko, G. S.; Tananaev, I. V.; Volodina, A. N. (Inst. of General and Inorganic Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1097-1107(July 1968). (In Russian).

Methods for the synthesis of neutral and acid selenites of Pr, Nd, Sm, Gd, and Y were developed on the basis of data obtained during the study of the solubility diagram in the systems MCl_3–H_2SeO_3–H_2O and M_2O_3–SeO_2–H_2O at 25°. Microphotographs, optical constants, and x-ray and infrared absorption spectra are reported for some of the compounds isolated. The thermal stability of the neutral and acid selenites of these metals was investigated. The regularity of the thermal behavior of the selenites is explained as a function of the atomic number of the metals. (tr-auth)

187 SYSTEM Eu_2O_3–Ta_2O_5. Pinaeva, M. M.; Krylov, E. I.; Ryakov, V. M. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1118-23(July 1968). (In Russian).

The system Eu_2O_3–Ta_2O_5 was investigated at 1350 and 1550° and the isothermal cross sections on the phase diagrams were constructed. The symmetry was established and the parameters of the elementary cell of the phases were calculated. Luminescence in the system was investigated. It was found that the character of the spectrum is preserved and the intensity of the luminescence is changed as a function of the composition of the system and the annealing temperature. Correlations between the luminescence intensity and the phase state of the system were detected. (tr-auth)

188 MASS SPECTRA OF BIS-1,3-DITHIOLANES AND BIS-1,3-DITHIANES. FRAGMENTATION MECHANISMS AND DEUTERIUM ISOTOPE EFFECTS. Shapiro, R. H.; McEntee, T. E. Jr.; Coffen, D. L. (Univ. of Colorado, Boulder, Colo.). Tetrahedron, 24: 2809-15(Mar. 1968).

The mass spectra of bis-1,3-dithiolanes and bis-1,3-dithianes show that three major fragmentation reactions are induced upon electron-impact. In addition to the expected α-cleavage, two ring cleavages occur with concomitant hydrogen migration. A deuterium isotope effect was observed for one of the ring cleavage reactions as well as for the α-cleavage process. The isotope effect data shed some light on the mechanisms of the cleavage reactions. (auth)

189 LUMINESCENCE OF Eu^{3+}-ACTIVATED THORIUM, ALKALI METAL VANADATES. Burrus, H. L.; Paulusz, A. G. (General Electric Co. Ltd., Wembley, Eng.). J. Electrochem. Soc., 115: 976-7(Sept. 1968).

Studies were made on the luminescence of vanadates with the zircon structure having the general formula $M_2(IV)M(I)(VO_4)_3$, where M(IV) is Th and M(I) is a univalent alkali metal. In all the complex vanadates examined, there was a steady fall in brightness as the temperature was raised. An exception was $CaTh(VO_4)$. In contrast the thorium vanadates with Li and Na were much brighter than YVO_4: Eu at room temperature so that, although they fell in brightness with increasing temperature, they were about equal in brightness to YVO_4: Eu at 200°C. This is within the range of the bulb wall operating temperature of low wattage high-pressure mercury vapor lamps, so these phosphors could possibly find application for color correction in this type of lamp. (P.C.H.)

190 THE NOVEL STRUCTURE OF $(NH_4)_4ThF_8$. Penneman, R. A.; Ryan, R. R.; Rosenzweig, A. (Los Alamos Scientific Lab., N. Mex.). Chem. Commun., No. 16, 990-1(1968). (LA-DC-9495).

In this compound the Th is nine-coordinated and one F in the structure is not involved in a Th–F bond. It is believed that this is the first known case where a higher coordination number is achieved by sharing fluorides, with exclusion of an F from the coordination sphere of the actinide. Thorium is the largest of the tetrapositive actinides, and is therefore the most likely to achieve 9- rather than 8-coordination. Since 9-fold coordination could be achieved in a compound of composition $(NH_4)_3$ Th F_7, the 4:1 stoichiometry is unexpected in this system. Preparation of $(NH_4)_4$ Th F_8 is outlined. The crystals are triclinic with a = 8.59, b = 8.41, c = 7.33Å, $\alpha = 88° 28'$, $\beta = 95° 46'$, $\gamma = 106° 49'$, space group $P\bar{1}$, z = 2, $D_c = 3.0$. The average U–F distance is 2.28Å, and the Th has nine F neighbors at an average distance of 2.40Å. The F coordination polyhedron around the Th is distorted from a tricapped trigonal prism of ideal D_{3h} symmetry. The remaining F lies approximately 5.04Å from its nearest Th neighbor, and this F, which is not bonded to Th, is surrounded by five N-atoms in an approximately square pyramidal configuration with an average N . . . . F distance of 2.74Å. (UK)

191 THEORY OF THE DEUTERIUM EFFECT OF THE J_{13CH} COUPLING CONSTANT. Rossi, Massimo. (Univ., Padua). Chem. Phys. Lett., 2: 353-5(Oct. 1968).

A theoretical explanation of the effect of deuterium substitution on the J_{13CH} coupling constant of a vicinal proton in tetrahedrally hybridized carbons is given. The change in time-averaged 2s character of the hybrid carbon orbital, due to the coupling of the bending vibrations, is calculated. The value of the related coupling constant is in good agreement with the experimental one. (auth)

192 EFFECT OF PARTIAL DEUTERATION ON BIPHENYL PHOSPHORESCENCE. Simpson, J. D. (Univ. of California, Santa Barbara); Offen, H. W.; Burr, J. G. Chem. Phys. Lett., 2: 383-4(Oct. 1968).

Phosphorescence lifetimes were measured for five partially deuterated biphenyls in EPA at 77°K. The data show that the number and position of symmetrically substituted deuterium atoms have a significant influence on triplet state lifetimes. It was found that proton substitution in the meta position is least effective in promoting radiationless transitions. (auth)

193 STRUCTURE DETERMINATION OF COMPOUND $CaUF_6$. Chebotarev, N. T.; Beznosikova, A. V. At. Energ. (USSR), 25: 321-4(Oct. 1968). (In Russian).

Published data on the structure of $CaUF_6$ are reviewed. Comparisons of previously obtained powder x-ray pictures of $CaUF_6$ indicated that $CaUF_6$ and LaF_3 have the same type structure. Parallel studies made with 0.3-mm diameter $CaUF_6$ monocrystals and LaF_3 and UF_3 crystals revealed a certain difference in the structure of these crystals that was assumed to be related to the different magnitudes of ioniradii of metals in these structures. The mean radius of metal atoms in $CaUF_6$ is equal to 0.965 Å [$r_{Me} = (r_{Ca^{+2}} + r_{U^{+4}}/2) = (1.04 + 0.89/2) = 0.965$ Å] and in LaF_3 and UF_3 it is equal to 1.04 Å. (R.V.J.)

194 SPEEDS OF DISMUTATION OF URANIUM(V) AND THE APPEARANCE OF URANIUM(IV) IN THE COURSE OF THE PHOTOREDUCTION OF URANIUM(VI) IN SULFURIC ACID MEDIUM. Bressat, Rene; Claudel, Bernard; Feve, Michel; Giorgio, Gerard (Institut National des Sciences Appliquees, Lyon). Compt. Rend., Ser. C, 267: 707-10(Sept. 16, 1968). (In French).

By simultaneous use of spectrophotometric and potentiometric techniques it was shown that at the time of the photoreduction of uranyl sulfate with ethanol in sulfuric acid medium the dismutation of uranium(V) is the elementary reaction that produces uranium(IV). (tr-auth)

195 VAPOR PHASE NITRATION OF ETHANE IN A BACK-MIX MOLTEN SALT REACTOR. Barberree, Daniel Albert. Ames, Iowa, Iowa State Univ., 1968. 105p.

Thesis.

Nitration of ethane with HNO_3 in the vapor phase was investigated in a molten salt reactor in which the reactants are ejected directly into the molten salt. Molten salt temperature was varied from 400 to 500°C and mole ratio of hydrocarbon to HNO_3 was varied from 3:1 to 17:1. Gas-chromatography techniques were developed, which provide on-line quantitative analysis of the reaction products. Complete product distributions were obtained for all experiments. The oxidation products, including formaldehyde, acetaldehyde, methanol, ethanol, CO, and CO_2, were present in greater quantity than the nitroparaffins formed. Yields based on HNO_3 ranged up to 76.08% while conversions based on HNO_3 were obtained up to 8.37%. Maximum hydrocarbon yield and conversion were 68.54% and 1.18%, respectively. A proposed free radical reaction mechanism including both nitration and oxidation reactions is discussed with reference to product distribution. (Diss. Abstr.)

196 EFFECTS OF DEUTERIUM SUBSTITUTION ON THE RATES OF SOLVOLYSIS OF SOME OPTICALLY ACTIVE α-PHENYLETHYL CHLORIDES. Vogel, Philip Christian. Bloomington, Ind., Univ. of Indiana, 1967. 125p.

Thesis.

An automatic data collection system was developed to code voltage output and elapsed time on punched paper tape for direct computer input. A computer program was developed to fit the data to a first order rate law, corrected for salt and mass law effects, using a Lagrange multipliers least squares technique. A technique was elaborated for determination of the polarimetric rate constants for the solvolysis of an alkyl ester with a precision of 1.0%. The conductance of HCl in 97% (volume) trifluoroethanol-water was determined and the results indicate that there is appreciable solvent dissociation. The polarimetric solvolysis rate constants were determined for α-phenylethyl chloride and for p-methyl and m-bromo substituted analogs in ethanol-water and trifluoroethanol-water. The methyl compound shows a β-isotope effect of 1.22 and no racemization, while the unsubstituted chloride showed 30 to 90% racemization and a β-isotope effect on racemization of 2.0. The m-bromo chloride showed no racemization rate and 50% inversion in the products. It is proposed that the solvolysis reaction goes through a series of ion pairs. The intimate ion pair, found initially, reacts with the solvent in such a way as to suggest that there is considerable bonding still remaining. It was found that the reactivity of the intimate ion pair increased in the order: p-methyl-α-phenylethyl chloride, α-phenylethyl chloride, m-bromo-α-phenylethyl chloride. There is a change in reaction with the solvent which follows the order, unimolecular dissociation of the intimate ion pair, unimolecular racemization (without exchange) of the ion pair, and nucleophilic attack of the solvent on the ion pair, when the reactivity of the ion pair is increased. A large isotope effect on the racemization rate is attributed to conjugation between the positive charge in the carbonium ion and the phenyl ring, which is lost in the transition state for racemization. (Diss. Abstr.)

197 SULFONE ANALOGS OF ANTICONVULSANT STRUCTURES. Chappelow, Cecil Clendis Jr. Kansas City, Mo., Univ. of Missouri, 1968. 183p.

Thesis.

This investigation was concerned primarily with the development of synthetic methods for preparation of sulfone analogs of structures that possess anticonvulsant properties. A study of the synthesis of N-acylsulfamides, the sulfone analogs of N-acylureas, yielded two new synthetic methods, two new compounds, and physicochemical information related to structure and chemical reactivity. All of the nitrogen-bound protons readily undergo exchange reactions with D_2O. A new method for the preparation of N-imidoylsulfamides was discovered which makes it possible to synthesize certain N-acylsulfamides which are not accessible by conventional acylation. Two new related condensation reactions of sulfamide were discovered, which make it possible to synthesize 3,5-diiminotetrahydro-1,2,6-thiadiazine 1,1-dioxides. By these newly discovered condensation reactions, the basic ring system was prepared in yields of 10 and 52% from diethyl malondiimidate and malondiamidine, respectively. In a similar manner, the 4,4-dimethyl compound was obtained from the corresponding imidate and amidine in yields 25 and 50%, respectively. The acid- and base-catalyzed tautomerization of both of the new compounds was studied by ultraviolet spectroscopy. The exchange reaction of these compounds with D_2O was studied by nuclear magnetic resonance spectroscopy. The synthesis of 3,5-dioxotetrahydro-1,2,6-thiadiazine 1,1-dioxides, the sulfone analogs of the barbiturates, was attempted by seven different synthetic approaches. Deamination of the perhydro 3,5-diimino compound resulted in ring cleavage. Substituted malonate esters failed to undergo base-catalyzed condensation with sulfamide. Sulfuryl chloride and disubstituted malondiamide failed to react. Malonyl dichloride and sulfamide yielded malonyl disulfamide instead of the cyclized product. Although disubstituted malonyl dichlorides failed to react with sulfamide, they reacted with N,N′-dilithiosulfamide to yield polymeric products with surfactant properties. An attempt to affect a carbodiimide-induced condensation between a dialkylmalonic acid and sulfamide yielded an acylurea. The synthesis of sec-butylethylcyanoacetylsulfamide was attempted by three different methods. N,N′-Bis(N,N-dimethylaminomethylene)sulfamide was obtained unexpectedly from an attempted sulfamide acylation reaction in which N,N-dimethylformamide was used as solvent. The preparation of 3-oxo-1,2,5-thiadiazolidine 1,1-dioxides, the sulfone analogs of the hydantoins, was studied briefly. Two synthetic routes to the 4,4-diphenyl compound, the sulfone analog of Dilantin were investigated. A modified Bucherer condensation of benzophenone, KCN and $(NH_4)_2SO_3$ was attempted without success. Also, an attempt to convert a 3,4-diphenyl-1,2,5-thiadiazoline 1,1-dioxide to the desired product was not successful. Preliminary pharmacological evaluation of N-phenylacetylsulfamide indicated that it was less than half as effective as Trimethadione on a molar basis as an anticonvulsant when tested in the cat against convulsant doses of pentylenetetrazol. Several of the most logical extensions of barbiturate and hydantoin synthetic methods were found to be inoperable with sulfamide and were eliminated from further consideration. (Diss. Abstr.)

198 ^{32}P-LABELING OF C_1-C_6 TRIALKYL PHOSPHATES BY ISOTOPIC EXCHANGE. Termens, L.; Schweer, K.-H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Radiochim. Acta, 9: 125-30(Aug. 1968). (In German).

$Fe^{32}PO_4 \cdot 2.5\ H_2O$ was used to mark C_1-C_6 trialkyl phosphates by means of an isotope exchange reaction. From the isotope exchange studied in dependence on time and temperature the exchange half-life values and the activation energies were determined. A dependence of the exchange half-life values of the

reactions on the chain length of the trialkyl phosphates was found. Some reaction mechanisms are discussed. (auth)

199 FLUID DENSITIES BY GAMMA RADIATION ABSORPTION. FLUID DENSITIES UP TO THE CRITICAL POINT BY GAMMA RADIATION ABSORPTION. Lluna, J. A. Burriel; Cragg, C. B.; Rowlinson, J. S. (Imperial Coll. of Science and Tech., London). An. Quim., 64: 1-8(Jan. 1968).

The development of a method that permits the determination of the critical properties (T_c,d_c) of substances for which the measurement proves to be difficult is described. The method used consists of the measurement of the densities of the liquid and vapor phases in an enclosed system when the temperature is increased. Owing to the increased coefficient of mass absorption of the three substances measured (I_2, BrI, Br_2), its density can be determined when enclosed in a steel container by means of the absorption of gamma rays that pass through it. In the discussion of the results it was observed that there was good agreement with the law of corresponding states for these three substances within the limits of experimental error. (tr-auth)

200 POLAROGRAPHIC STUDY OF Zr(IV) IN DMSO AND DMSO–20 PERCENT H_2O. Sancho, J.; Pujante, A. (Univ., Murcia, Spain). An. Quim., 64: 9-14(Jan. 1968). (In Spanish).

A study of Zr(IV) in anhydrous DMSO and DMSO–H_2O 20% has been carried out, using LiCl 0.1 M as support electrolyte. A well-defined wave has been observed in anhydrous DMSO at –0.991 V vs EPR, its height being proportional to the concentration of that element. In the study of DMSO–20% H_2O, two waves have been observed: one at –1.071 V vs EPR, kinetic in character, and another at –1.572 V vs EPR of similar characteristics to the wave appearing in anhydrous DMSO. The behavior of the waves has been studied in different conditions of temperature, height of mercury column, and water concentrations, in order to verify their influence on the polarograms. The concentration range studied was from 1.5×10^{-3} to 4.5×10^{-3} M. The values for the diffusion current constant are the following: 0.218 in DMSO, and 0.662 in DMSO–20% H_2O (2nd wave); the half-wave potentials are: –0.991 V vs EPR with DMSO, and 1.071 (first wave) and –1.572 (second wave) V vs EPR with DMSO–20% H_2O; the peak potentials are: –1.051 V vs EPR with DMSO; –1.141 V (first wave) and –1.629 V (second wave) vs EPR with DMSO–20% H_2O. (auth)

201 USE OF SYNTHETIC INORGANIC ION EXCHANGERS IN THE SEPARATION OF URANIUM, PLUTONIUM, AND FISSION PRODUCTS. II. THE IONS Sr^{2+}, Ce^{3+}, Zr^{4+}–Nb^{5+}, Ru, AND Al^{3+}. Parra, M. Rodriguez; Hueda, A. Uriarte; Perez, B. Lopez (Junta de Energia Nuclear, Madrid). An. Quim., 64: 83-8(Jan. 1968). (In Spanish).

The variation of the distribution coefficients K_D, for strontium, cerium, zirconium, ruthenium, and aluminum ions in nitric solution with the synthetic inorganic ion exchangers, Silica Gel (<200 mesh) and Unfired Vycor Glass (100 to 200 mesh) has been studied. The exchangers were first treated with 5 M nitric acid and dried at 100°C. The equilibrium times have been determined. The effects of temperature, nitric acid concentration and ion concentration in the aqueous phase, on the distribution coefficients have also been studied. The results obtained show that only zirconium–niobium are loaded in both exchangers with distribution coefficients of 2000 and 300, respectively, for Silica Gel and Unfired Vycor Glass. (auth)

202 ION-BINDING MEASUREMENT BY ISOTOPIC EXCHANGE. Cho, C. M.; Greco, J.; Kaplan, E. (Veterans Administration Hospital, Hines, Ill. Loyola Univ., Hines, Ill. Univ. of Illinois, Chicago). J. Nucl. Med., 9: 175-7(May 1968).

A method to determine the fraction of an ion to ion-binding substance in aqueous solution is presented. The principle of the method is based on altering the isotopic exchange constant across a rate-limiting membrane due to interaction of the diffusible ion with ion-binding substance. The relationship between the degree of alteration in the isotopic-exchange constant and the fraction of the bound form was derived. The proposed method does not require the separation of a particular ion under investigation into bound and free forms for quantitative estimation. The presence of other ions does not interfere. Some limitations concerning the alteration in the membrane permeability due to interaction between ion-binding substance and membrane and the right choice of dialyzate concentration are also discussed. (auth)

203 REGULARITIES IN THE DISTRIBUTION OF TTA AND ITS SCANDIUM CHELATE INTO A SERIES OF ESTER SOLVENTS. Suzuki, Nobuo; Akiba, Kenichi; Kanno, Takuji (Tohoku Univ., Sendai). Anal. Chim. Acta, 43: 311-20(Nov. 1968).

The distribution ratios of TTA and its scandium chelate between aqueous perchlorate solutions (μ = 0.1) and 15 ester solvents including ethyl acetate were determined at 25°C. A good correlation was found between the distribution coefficients of TTA and the "solubility parameter" of the ester solvents. The relationship between the distribution coefficients of the scandium chelate (P_M) and those of TTA (P_{HA}) was shown to be, $\log P_M = n \log P_{HA} +$ const. The distribution of this chelate into another ester can thus be predicted. (auth)

204 VOLTAMMETRIC BEHAVIOR OF NEPTUNIUM(VI) IN GLUTAMIC ACID MEDIA AT THE ROTATING GLASSY CARBON ELECTRODE. Plock, C. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. Anal. Chim. Acta, 43: 281-7(Nov. 1968).

The voltammetry of neptunium(VI) glutamate was investigated over the pH range 3.8 to 10.0. A reversible, one-electron wave was obtained for glutamate concentrations above 0.1 M in the pH range 3.8 to 0.1, or above 0.3 M in the pH range 6.1 to 10.0. At pH 3.8 to 6.1, the half-wave potential was independent of pH, but at pH 6.1 to 10.0, it was a function of pH. The metal–ligand ratio was found to be 1:2 by conductometric titration. The limiting current was proportional to the concentration of the neptunium(VI) from 7.83×10^{-5} to 1.96×10^{-3} M. The diffusion coefficient was 0.35×10^{-6} cm^2 sec^{-1} at pH 4.5 and 0.30×10^{-6} cm^2 sec^{-1} at pH 9.4. (auth)

205 ELECTROMETRIC STUDIES ON THE COMPOSITIONS OF URANYL ISOPOLYTUNGSTATES. Joshi, M. P.; Gupta, C. M. (Univ. of Rajasthan, Jaipur, India). Z. Naturforsch., 23b: 1270-2(Sept. 1968).

Studies were made on the reaction equilibria between uranyl nitrate, $UO_2(NO_3)_2$ and various isopolytungstates by amperometric, pH, and conductometric methods of titrations. The results confirmed the formation and precipitation of normal, para, and tritungstates of uranyl having the compositions, $UO_2 \cdot WO_4$, $UO_2 \cdot W_2O_7$, and $UO_2W_3O_{10}$ at pH ranges of 4.5 to 4.80, 3.5 to 3.8, and 3.0 to 3.35, respectively. (P.C.H.)

206 MECHANISM OF THE ACID CATALYZED HYDRATION OF PHENYLBENZOYLACETYLENE. De Bruin, Kenneth Edward. Berkeley, Calif., Univ. of California, 1967. 155p.

Thesis.

Phenylbenzoylacetylene (indexed as 3-phenylpropiolophenone) hydrates at a convenient rate in 70% sulfuric acid at 25°C to form enolic benzoylacetophenone. The oxonium salt of phenylbenzoylacetylene is present in substantial quantities at the acid concentrations employed in the hydration studies. Substituent effects, isotope effects, and temperature effects on the acidity constant of the conjugate acid were studied to determine its role in the overall mechanism of hydration. Pseudo first order hydration rate constants, corrected for the equilibrium concentration of the oxonium salt, for p-methoxyphenylbenzoylacetylene, p-methylphenylbenzoylacetylene, phenylbenzoylacetylene, phenyl-p-methylbenzoylacetylene, and phenyl-p-nitrobenzoylacetylene are proportional to h_0; plots of log k vs H_0 have approximately unit slopes. Substituents in the "phenyl" ring of phenylbenzoylacetylene have a large effect on the hydration rate constants. A correlation of the logarithm of the rate constants, extrapolated to $H_0 = -4.0$, with σ^+ gave a ρ of –4.2. "Benzoyl" substituents produce a small effect on the hydration rate constants; a correlation with σ gave a ρ of –0.4. p-Methoxyphenylbenzoylacetylene hydrates 17 times faster than phenyl-p-methylbenzoylacetylene. p-Methoxy-, p-Methyl-, and unsubstituted phenylbenzoylacetylene hydrate some 2 to 3 times faster in a protium medium than in a deuterium medium at the same mole fraction sulfate. Rate constants determined at 25 and 45°C for the three compounds correspond to entropies of activation of approximately –30 eu. These results are most consistent with a mechanism involving an equilibrium protonation of the carbonyl oxygen competing with rate limiting proton transfer to the α-carbon of the acetylenic bond. The resulting benzyl vinyl cation then rapidly adds water to yield the enolic benzoylacetophenone. (Disser. Abstr.)

207 POTENTIAL ENERGY CONSTANTS AND MEAN AMPLITUDES OF VIBRATION FOR THE ISOTOPIC SPECIES OF HYDROGEN DIFLUORIDE ION. Shanmugasundaram, G. (Coll. of Engineering, Madras). Acta Phys. Pol., 34: 547-51(1968).

A brief account of the vibrational and structural analysis of hydrogen difluoride ions and deuterium difluoride ions possessing a linear symmetrical structure is given. On the basis of group theoretical considerations, potential energy constants were evaluated by employing a three-constant valence force field. Mean-square amplitude quantities and mean amplitudes of vibration for both bonded and nonbonded atom pairs were also computed at the temperatures 500 K, 750 K, and 1000°K. The results are discussed on the chemical significance of the characteristic bonds. (auth)

208 NEPTUNIUM(V) AND (VI) OXYFLUORIDES. Bagnall, K. W.; Brown, D.; Easey, J. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Soc., A, No. 9, 2223-7(1968).

Neptunium(V) oxytrifluoride, $NpOF_3$, and neptunyl(VI) fluoride, NpO_2F_2, are obtained by treating Np_2O_5 and NpO_3, H_2O, respectively, with anhydrous, gaseous hydrogen fluoride. NpO_2F_2 can also be prepared by a variety of other methods including direct fluorination of Np_2O_5 or NpO_3, H_2O at 350 and 225°C, respectively. Attempts to reduce NpO_2F_2 to NpO_2F have resulted in the formation of pentavalent oxyfluoride products of variable composition. X-ray powder diffraction patterns for products in the range of composition $NpO_{1.96}F_{1.08}$–$NpO_{1.8}F_{1.4}$ are identical. Some chemical properties, ir spectra and x-ray powder diffraction results are reported for these oxyfluorides. (auth) (UK)

209 DIPOLAR ADDITION VERSUS OXYGEN TRANSFER IN THE REACTION OF TETRACYANOETHYLENE OXIDE WITH UNSATURATED HYDROCARBONS. Brown, P.; Cookson, R. C. (Southampton Univ., Eng.). Tetrahedron, 24: 2551-66(Mar. 1968).

With the single exception of anthracene, which yields the unsymmetrical adduct (VA), olefins, polyenes, and aromatic compounds react with tetracyanoethylene oxide (indexed as 1,2-epoxy-1,1,2,2-ethanetetracarbonitrile) to give symmetrical 2,2,5,5-tetracyanotetrahydrofurans. With the more nucleophilic olefins, including anthracene, oxygen transfer also occurs, forming ketones and tetracyanoethylene or its adducts with the olefin. The adduct (VA) of 9-deuterioanthracene and tetracyanoethylene oxide has 19% excess of deuterium on the carbon linked to the oxygen atom (i.e., VA; R_1 = D, R_2 = H is formed faster than VA; R_1 = H, R_2 = D). This large isotope effect agrees with a reaction mechanism in which the first stage is attack on the electrophilic oxygen atom of tetracyanoethylene oxide followed by rapid cyclization of the dipolar intermediate. (auth)

210 SOLUBILITY AND DIFFUSION OF HYDROGEN AND DEUTERIUM IN PLATINUM. Ebisuzaki, Y.; Kass, W. J.; O'Keeffe, M. (Arizona State Univ., Tempe). J. Chem. Phys., 49: 3329-32(Oct. 15, 1968).

The diffusion and solubility of hydrogen and deuterium in monocrystalline platinum have been studied by a permeation method. The diffusion coefficient of hydrogen is $D = (6.0 \pm 3.5) \times 10^{-3} \exp(-5.9 \pm 1.0 \text{ kcal/RT}) \text{ cm}^2 \text{ sec}^{-1}$, and the solubility in atom fraction H/Pt is given by $S = 1.2 \times 10^{-3} \exp(-11 \text{ kcal/RT})$. The isotope effects in permeation and diffusion ($D_1/D_2 = 1.16 \pm 0.04$ at 750°K) are analyzed in terms of an earlier theory. An Appendix discusses quantitatively errors due to absorption of gas by the walls of the apparatus in this type of experiment. (auth)

Radiation and Nuclear Chemistry

Refer also to abstracts 102, 349, 351, and 1991.

211 (BNL-tr-223) KINETICS OF THE RADIATION-THERMAL DECOMPOSITION OF NO_2 IN FLOW. Nichipor, G. V. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 29-34(1967). 11p. Dep. CFSTI.

Simplified equations of energy and mass transfer are given for the kinetics of chemical reactions in one-dimensional flow. An attempt is made to describe the kinetics of the radiation-thermal decomposition of NO_2 in one-dimensional flow. Eight differential equations of the first order are derived for the time distribution of the mixture components, and the rate constants k_j of the different reactions are tabulated. (D.L.C.)

212 (COO-1088-29) ULTRAVIOLET AND INFRARED SPECTRA OF FREE RADICALS IN IRRADIATED POLYETHYLENE. Dole, Malcolm; Boehm, G. G. A. (Northwestern Univ., Evanston, Ill.). Jan. 19, 1968. Contract AT(11-1)-1088. 19p. (CONF-680806-2). Dep. CFSTI.

From Conference on Radiation Chemistry, Argonne, Ill.

The ultraviolet and infrared spectra of free radicals in irradiated polyethylene are discussed and compared with theoretical expectations and with observations of others. (auth)

213 (IS-1900, Paper 3) CHEMISTRY DIVISION. Spedding, F. H.; Hansen, R. S.; Banks, C. V.; (and others) (Ames Lab., Iowa). 114p.

Research progress is reported on: reactions and properties of metals in low oxidation states, x-ray diffraction, high-temperature chemistry, coordination chemistry, exchange and substitution reactions, chemistry of the heavy transition elements, magnetic resonance, rare earth separations, theoretical chemistry, neutron diffraction, analytical separations and operations, new organic analytical reagents, spectroscopy, kinetics and mechanisms of inorganic reactions, thermodynamic and magnetic properties of solids, surface chemistry, thermodynamic properties of rare earth electrolytes, chemical mass spectrometry, and radiochemistry and activation analysis. (M.C.G.)

214 (NP-17579, pp II.1-5) PRODUCTION AND APPLICATION OF RADIOISOTOPES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Production and sale of radioisotopes and labeled compounds and production of gamma sources are considered. Facilities built in 1967 are described. Studies were made on the purification and preparation of $^{227}Ac_2O_3$ for use as a heat source in thermionic generators. The fuel conditioning and metallurgical properties of Ac_2O_3 were investigated. (M.C.G.)

215 (NYO-2735-9) CHEMICAL EFFECTS OF IONIZING RADIATIONS ON THE INDIVIDUAL AMINO ACIDS WITHIN INTACT AND PURE PROTEIN MOLECULES. Annual Progress Report, 1968-1969. Friedberg, Felix (Howard Univ., Washington, D. C. Dept. of Biochemistry). Oct. 30, 1968. Contract AT(30-1)-2735. 14p. Dep. CFSTI.

Exposure of lyophilized native ribonuclease or lysozyme in vacuo to about 30 Mrads caused aggregation of the protein molecules. There was no evidence of extensive degradation of these globular molecules. 5 M Guanidine HCl did not disassemble the aggregated material. If the S-carboxymethylated form of ribonuclease or lysozyme was exposed to gamma rays, there was also no indication of marked degradation of the polypeptide chain and again the molecules were prone to aggregate. On the other hand, lathyritic collagen exhibited a definite lowering of molecular weight, under the same conditions. (auth)

216 (ORNL-4272, pp 218) IRRADIATION EFFECTS ON HETEROGENEOUS SYSTEMS. (Oak Ridge National Lab., Tenn.).

The study of the radiolysis of adsorbed water was completed. It was found that energy adsorbed by the solid adsorbent is transferred to the surface in the form of electrons, which react with acid hydrogen sites to give enhanced gaseous hydrogen yields. (auth)

217 (ORNL-4306, pp 58-65) RADIATION CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: yield of ozone in the pulse radiolysis of gaseous oxygen at very high dose rate for use as a dosimeter; a high-intensity square-wave analytical flash lamp; radioinduced oxidation of Ce(III) in deaerated sulfuric acid solutions; reduction of Ce(IV) by hydrogen peroxide; alpha-particle recoil tracks in mica; energy transfer in the radiolysis of organic compounds; and radiation and hot-atom chemistry of inorganic crystalline solids.

218 (ORNL-4306, pp 66-72) ORGANIC CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: photodimerization of isophorone; and an isotope effect on a spin-spin coupling constant. (P.C.H.)

219 (ORO-3602-2) REACTIONS OF CHARGED AND NEUTRAL RECOIL PARTICLES FOLLOWING NUCLEAR TRANSFORMATIONS. Progress Report No. 2, September 1967-August 1968. Ache, Hans J. (Virginia Polytechnic Inst., Blacksburg. Dept. of Chemistry). Sept. 1968. Contract AT(40-1)-3602. 30p. Dep. CFSTI.

A technique for determination of the oxidation states of a recoil particle when it comes to rest, isotope effects in hot atom reactions, and the crystallochemical reactivity of recoil species after they have become thermalized in a solid matrix are considered. (M.C.G.)

220 (RRL-2310-226) ELECTRON SCAVENGING PROCESSES IN THE RADIOLYSIS OF HYDROCARBON SOLUTIONS. Warman, John M.; Asmus, K.-D.; Schuler, Robert H. (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Jan. 26, 1968. Contract AT(30-1)-2310. 62p. (CONF-680806-4). Dep. CFSTI.

From Conference on Radiation Chemistry, Argonne, Ill.

The current state of knowledge of electron scavenging processes in liquid hydrocarbons is summarized. The interpretation of data is critically discussed in the light of possible complicating factors. The relation $G(S^-) = G_{fi} + \{G_{gi}(\alpha_s[S])^{\frac{1}{2}}/(1 + (\alpha_s[S])^{\frac{1}{2}})\}$ is found to describe the concentration dependence of electron scavenging in a number of cases. Using this relation it is shown that a detailed treatment of the scavenging kinetics in competitive situations is possible. Secondary reactions involving negative ions are postulated to explain anomalies found in the available data. (auth)

221 OXYGEN EFFECT ON GAMMA IRRADIATED FROZEN SOLUTIONS IN TETRAHYDRONAPHTHALENE. Kecki, Zbigniew; Kosek, Stanislaw; Stachowicz, Waclaw (Inst. of Nuclear Research, Warsaw). Nukleonika, 13: 805-13(1968).

The changes in the EPR spectrum during the warming of irradiated at 77°K solutions of various organic substances in tetrahydronaphthalene were studied. During the warming after irradiation a magnificent increase of radical concentration and a change of radicals into peroxy-radicals were observed within the temperature range of 150 to 180°K. At higher temperatures the EPR signal disappeared due to the recombination of radicals. Attempts to explain this unexpected increase of radical concentration are presented. (auth)

222 PROCEEDINGS OF THE NUCLEAR AND RADIATION CHEMISTRY SYMPOSIUM, POONA, MARCH 6-9, 1967. Bombay, Department of Atomic Energy, 1967. 555p. (CONF-670335).

Separate abstracts were prepared for 51 of the 63 papers. The remaining papers covered Moessbauer spectroscopy, preparation of labeled compounds, tracer studies, and general chemical reactions. (M.C.G.)

For abstracts of individual papers see: 19-23, 114, 117-126, 232, 241-252, 259, 375-386, 462, 780, 975, 990, 1064, 1835, and 1891-1893.

223 EPR SPECTRA OF SOME GAMMA-IRRADIATED N-SUBSTITUTED MALEAMIC ACIDS AND MALEIMIDES. Istratoiu, Rodica; Farcasiu, Malvina; Nicolau, Claude (Center for Radiobiology and Molecular Biology, Bucharest). Bull. Soc. Roy. Sci. Liege, 37: 245-9(1968).

The structure of free radicals formed in the γ-irradiation of substituted maleamic acids and maleimides was confirmed by EPR spectral studies. (J.G.B.)

224 STUDIES ON AZULENES. [Part] III. THE IRRADIATION EFFECT ON AZULENES. THE γ-RAY IRRADIATION ON GUAIAZULENE. Otani, Yasushi (Konan Kako Co., Ltd., Japan). Yakugaku Zasshi, 88: 795-801(July 1968). (In Japanese).

The retention time of the reduction products in gas chromatography, and hence their quantitative determination, was concluded from the change of peaks, in the process of reduction of guaiazulene and decahydroguaiazulene by absorbing 1, 2, 3, 4, and 5 moles of H on guaiazulene. By the absorption of one mole of hydrogen, even though in a very minute amount, di-, tetra-, hexa-, octa-, and decahydroguaiazulene are formed and up to 2 mole absorption of H, unreacted guaiazulene was found to be present, and as the reduction proceeds, the color changed from violet blue to greenish blue, greenish yellow, and colorless finally. Irradiation of the guaiazulene solution with γ radiation produced di-, tetra-, hexa-, octa-, and decahydroguaiazulene, which were identified from the retention time of gas chromatography. The greater the concentration and irradiation, the greater the reduction and, even though it is a trace, five kinds of reduction products were identified after 10^2 R irradiation. On the other hand, by the irradiation of decahydroguaiazulene, prepared by the catalytic reduction, lower reduction compounds were produced. That is, after the dehydrogenation, guaiazulene and hydroguaiazulene are transformed to faint yellowish orange oxygen-containing crystal by the γ irradiation, but no product was identified that had not been recognized with decahydroguaiazulene. The irradiated samples became sticky and the γ irradiation was found to cause oxidation, reduction, and also polymerization. (NSA of Japan)

225 RADIATION POLYMERIZATION OF 3-VINYL-9-ISOPROPYLCARBAZOLE AND ELECTROPHYSICAL BEHAVIOR OF THE POLYMER. Budnikova, E. S.; Sirotkina, E. E.; Lopatinskii, V. P.; Igumnova, M. A. (Inst. of Physics and Tech., Novosibirsk, USSR. Tomsk Polytechnic Inst., USSR). Vysokomol. Soedin., Ser. B, 10: 447-8(June 1968). (In Russian).

The polymerization of 3-vinyl-9 isopropylcarbazole was achieved by irradiation with ^{60}Co γ rays with a dose of 7.6×10^3 R/hr. The regular structure polymer obtained possessed the higher activation energy, temperature of vitrification, and density than of the amorphous 3-vinyl-9 isopropylcarbazole prepared by thermal polymerization. (R.V.J.)

226 EFFECT OF ULTRAVIOLET AND X-RAY IRRADIATION OF PHOSPHORS. Bauer, George T. (Xerox Corp., Rochester, N. Y.). J. Electrochem. Soc., 115: 1176-80(Nov. 1968).

The effect of long term ultraviolet and x-ray irradiation on the luminous efficiency, reflectance, and glow curves of several inorganic phosphors was measured. It was found that the decrease of their luminous efficiency caused by irradiation was always accompanied with an increased absorption in the uv and in the visible regions of the spectra. The depreciation of x-rayed phosphors could in most cases partially, and in several phosphors fully, be interpreted in terms of the absorbing effect of centers produced by the irradiation. However, in phosphate types and in magnesium germanate phosphors an additional process contributes to their depreciation. This process is related to the appearance of new peaks on their glow curves. The observed wavelength dependence of the loss in luminous efficiency was measured for several phosphors and in each case could be attributed to color center absorption. The x-ray and uv irradiation resulted qualitatively in the same type of changes in the measured optical data. (auth)

227 EFFECTS OF CHEMICAL AGENTS ON THE SOLID-STATE RADIATION-CHEMICAL POLYMERIZATION OF ACRYLAMIDE, METHACRYLAMIDE, AND CERTAIN N-TER-ALKYL-ACRYLAMIDES. I. OXYGEN EFFECTS. Widerski, Jan; Zurakowska-Orszagh, Janina (Univ. of Warsaw). Rocz. Chem., 42: 1299-1305(1968). (In French).

The effect of the presence of oxygen during irradiation on the rate of radioinduced solid-state polymerization of acrylamide, methacrylamide, N-cyclohexylacrylamide, and a series of N-tert-alkylacrylamides was investigated. (auth)

228 VINYL-CELLULOSE COPOLYMERS. PART II. FIBROUS STRUCTURE AND PROPERTIES OF POLY (ALKYL METHACRYLATE)-COTTON COPOLYMERS PREPARED BY RADIATION-INITIATED REACTIONS. Blouin, Florine A.; Cannizzaro, Anna M.; Arthur, Jett C. Jr.; Rollins, Mary L. (Southern Regional Research Lab., New Orleans). Text. Res. J., 38: 811-16(Aug. 1968).

Graft copolymerization reactions of methyl, ethyl, butyl, hexyl, and lauryl methacrylates and 1,3-butylene dimethacrylate with fibrous cotton cellulose were initiated by the simultaneous irradiation procedure, using ^{60}Co γ-radiation. The fabric properties of the poly(alkyl methacrylate)-cotton copolymers (methyl, ethyl, butyl, and hexyl) were determined at two degrees of grafting. The flex abrasion resistance of the poly(hexyl methacrylate)-cotton copolymer at 37% add-on of polymer was more than two-fold that of the cotton fabric control. The flat abrasion resistance of the poly(ethyl methacrylate)-cotton copolymer was ten-fold greater than that of the fabric control. Examination of electron microphotographs of thin sections of the copolymers embedded in aqueous polyvinyl alcohol indicated that layer opening of the fibrous structure occurred during graft copolymerization and that the degree of layering and size of the opening was related to the molecular weight of the monomer being reacted. The radiochemical yields of the reactions ranged from 4,600 to 44,000 molecular actions per 100 eV at a dosage of 0.5 MR. (auth)

229 ACTION OF GAMMA RADIATION ON LIQUID 1.5-PENTANEDIOL. Barker, S. A.; Brimacombe, J. S.; Milner, D. J. (Univ. of Birmingham, Eng.). Radiat. Res., 35: 421-7 (1968).

The effects of γ rays on degassed, liquid 1,5-pentanediol were investigated. The major products, as shown by isotope dilution analysis, are 5-hydroxyvaleraldehyde, 1,5,6,10-decanetetraol, formaldehyde, 1-butanol, and 3-buten-1-ol. Glutardialdehyde and 1-pentanol are formed to a lesser extent. The products account for about 80% of the degraded 1,5-pentanediol for which G = 8.1 was found. Water is also formed with G = 1.0. The results are interpreted in terms of an initially formed parent molecule ion and its subsequent reactions. (auth)

230 RADIOLYSIS OF AQUEOUS TELLURIUM SOLUTIONS BY γ RAYS. III. ACIDIC SOLUTIONS. Haissinsky, Moise (Univ., Paris). J. Chim. Phys., 65: 1386-92(July-Aug. 1968). (In French).

The rate constants of the reactions (1) Te(IV) + OH and (2) Te(VI) + H were determined by competition with H_2O_2 + OH and H_2O_2 + H: $k_1 = 4.7 \times 10^9$ and $k_2 = 1.05 \times 10^8$ M^{-1} s^{-1}, respectively. In degazed solution, neither the oxidation, nor the reduction is complete but after a sufficient irradiation, a "quasi-equilibrium" state is apparently established. It is shown that this is due to the competition between the tellurium compounds and the stable radiolytic products (H_2O_2, O_2, H_2) for the free radicals OH and the H atoms. The concentration of OH and H at the quasistationnary state is estimated for high doses. (auth)

231 RADIOLYSIS OF FREMY'S SALT IN THE PRESENCE OF SOME HYDRATED ELECTRON SCAVENGERS IN ALKALINE AQUEOUS SOLUTION. Mantaka, Anastasia; Rakintzis, N. (Democritos Nuclear Research Center, Athens). Israel J. Chem., 6: 85-9(Mar.-Apr. 1968).

Fremy's salt, $K_4[ON(SO_3)_2]_2$, yields, in water, relatively stable solutions of the nitrosodisulfonate radical ion $ON(SO_3)_2^{2-}$. The free radical nitrosodisulfonate, irradiated with γ rays in aerated or deaerated aqueous alkaline solutions, shows a maximum yield of decomposition of 6.1, corresponding to the total radical

yield $G_{OH+H+e^-_{aq}}$. Results of irradiation of the salt in alkaline aqueous solutions (pH 10 to 11) in the presence of nitrate ions and nitrous oxide are reported. Irradiations were carried out with ^{60}Co at a dose rate of ~5000 RAD/min. In deaerated alkaline aqueous solutions in the presence of N_2O an increase of the $G(-ON(SO_3)_2^{2-}) = G_{OH+H+e^-_{aq}}$ from 6.1 to about 6.7 was observed within a limited range of concentration, while with NO_3^- the change was gradual. This is consistent with NO_2 and OH being produced, respectively, in the reaction of e^-_{aq} with the Fremy's salt, taking place in 1-electron-equivalent processes, and with the assumption that pairs of radicals may originate from water molecules. The presence of suitable scavengers prevents the recombination of their partners. The reaction $(OH \ldots\ldots e) + N_2O \rightarrow N_2 + OH + O^-$ is expected to take place, providing additional radicals to the system. (BBB)

232 (n,γ) RADIOLYSIS OF CHLOROFORM AND CARBON TETRACHLORIDE. Arnikar, H. J.; Dedgaonkar, V. G. (Univ. of Poona). pp 1-10 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Pure samples of carbon tetrachloride and chloroform subjected to (n,γ) radiolysis were treated with water and the ^{38}Cl activity determined in the organic and aqueous layers. Both Cl^- and CCl^- were detected in the latter. These constituted about 27% each in CCl_4, the rest of the activity being in the organic form. In the case of chloroform the relative yield of CCl^- was about 7% compared to 52% of Cl^-. The application of a dc electric field across silver electrodes showed the presence of both positively and negatively charged species, the proportion of the ^{38}Cl activity appearing as charged species being about 18 and 23% in CCl_4 and $CHCl_3$, respectively. In both cases the yield of the negatively charged species was slightly in excess of the positively charged species. Conductivity measurements at different time intervals following irradiation showed the presence of at least two types of charged species in $CHCl_3$, one losing the charge rapidly (within about 3 to 4 minutes) and the other being fairly stable up to about an hour. The more stable species appeared to be in a 4:3 excess compared to the short-lived form. Further studies are in progress to identify the probable nature of the different charged species formed in the (n,γ) radiolysis of these organic halogen compounds. (auth)

233 EFFECT OF TEMPERATURE ON DECAY OF RADICALS FORMED DURING RADIOLYSIS OF SOLID RUBBERS. Kozlov, V. T. (Scientific Research Inst. of the Tire Industry, Moscow). Rubber Chem. Technol., 41: 678-84(June 1968).

Temperature-time curves for radical decay, when radicals formed in rubbers by low-temperature radiolysis (-196°C, ^{60}Co, 522 RAD/sec) are heated, were studied by EPR. Materials studied included natural rubber, polyisoprene, polychloroprene, polybutadiene, butadiene-styrene rubber, and ethylene-propylene rubber. The rubbers were purified by extraction with cold acetone for 40 hr, followed by 2 reprecipitations from benzene by methanol. Radical decay processes began much below T_g, with simple increase in the amplitude of thermal vibrations. Extent of decay was greater the lower the steric hindrance in the monomer unit. The contribution of the sudden change in the region of T_g in the processes of unfreezing of motion and decay of radicals was greater in rubbers with side chains. Results obtained permitted determination of a number of important energy characteristics of the polymers, in particular molecular energy barriers, U_T, activation energies for radical decay, E_T, and energies of thermal motion at which radical decay began. The radical decay process at low temperatures began before movement of macromolecules relative to one another and was dependent on a migration mechanism with very low energy of activation. This process consists of migration of secondary ions formed by capture of charges by free radicals. Schemes of radical decay processes involving a combination of reactions between radicals and secondary ions of radical origin are suggested. (BBB)

234 CHEMISTRY OF ^{38}Cl RECOILS IN NEUTRON-IRRADIATED CRYSTALLINE $KClO_2$, $KClO_3$, AND $KClO_4$. Boyd, G. E.; Larson, Q. V. (Oak Ridge National Lab., Tenn.). J. Amer. Chem. Soc., 90: 5092-6(Sept. 11, 1968). (ORNL-P-3724).

The distribution of recoil 37.5-min ^{38}Cl among the chlorine valence states following the $^{37}Cl(n,\gamma)^{38}Cl$ reaction at 35°C in crystalline $KClO_2$, $KClO_3$, and $KClO_4$ was measured. Anion-exchange column separations performed on aqueous solutions of the irradiated solids showed that radiochloride was the principal species formed. The production of $^{38}ClO_3^-$ and of $^{38}ClO_2$ was observed for the first time, as was the formation of $^{38}ClO_3^-$ in $KClO_2$ and of $^{38}ClO_4^-$ in $KClO_3$. The generation of small amounts of radioperchlorate ion in irradiated $KClO_4$ was confirmed. Radiohypochlorite appeared to be formed in very small yield, if at all. Comparisons of the relative yields of the chlorine valence states produced by ^{60}Co γ-radiation with those for recoil radiochlorine indicated that the rupture of all the Cl-O bonds in the target anion is much more probable in the "hot-atom" than in the radiation chemical process. (auth)

235 ANALYSIS OF THE RECOIL PRODUCTS IN NEUTRON-IRRADIATED PHENYLARSENIC COMPOUNDS. PART 2. TETRAPHENYLARSONIUM COMPOUNDS AND PENTAPHENYLARSENE. Grossmann, G. (Technische Univ., Dresden). Isotopenpraxis, 4: 268-70(July 1968). (In German).

A separation method permitting the determination of yields of activities was elaborated for mono-, di-, and triphenylarsenic compounds, for tetraphenylarsonium compounds, for pentaphenylarsenic as well as for non-organically bounded arsenic in neutron-irradiated tetraphenylarsonium compounds and in pentaphenylarsenic. Extraction, ion exchange, and chromatography on Al_2O_3 were used as separation methods. Utilizing the principle of the isotope dilution analysis crystallization or precipitation reactions were employed for purification and the yield determination of di- and triphenyl arsenic products as well as of tetraphenylarsonium compounds. (auth)

236 ISOTOPE EFFECTS ON THE HYDROGEN FORMATION REACTION IN THE RADIOLYSIS OF CYCLOPENTANONE. Unoura, Kinya; Aikawa, Masayuki; Katayama, Meiseki (Hokkaido Univ., Sapporo). Bull. Chem. Soc. Jap., 41: 1734(July 1968).

Hydrogen and deuterium yields from the γ radiolysis of cyclopentanone, cyclopentanone-d_8, 2,2,5,5-cyclopentanone-d_4, and a mixture of cyclopentanone and cyclopentanone-d_8 were analyzed. Deviations in experimental and theoretical results indicate isotope effects as well as contributions from molecular and hot hydrogens in the hydrogen formation reaction. (J.G.B.)

237 RADIOLYSIS OF BINARY MIXTURES. PART II. THE EFFECT OF IRRADIATION TEMPERATURE ON THE RADIOLYSIS YIELDS OF METHANOL IN BENZENE. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Kensington). J. Chem. Soc., A, No. 10, 2408-12(1968).

The effect of irradiation temperature on the yields of radiolysis and scavenging products from methanol and methanol-benzene solutions was examined over the temperature range +110 to -196°C. The temperature-dependence of the yield of the radiolysis products is generally small. The results were examined in terms of current theories of radiation chemistry, including the hot-species model and the thermal-spike concept. The yields of the scavenging products cyclohexa-1,4-diene, anisole, and phenylcyclohexadiene displayed an inverse temperature-dependence, while the yield of cyclohexadienylmethanol displayed a complex temperature-dependence. The results, particularly for the hydrogen and cyclohexa-1,4-diene yields, appear to demonstrate a direct relationship between the decrease in hydrogen yield and the yield of cyclohexa-1,4-diene from methanol containing any initial benzene concentration. (auth) (UK)

238 RADIOLYSIS OF LIQUID BENZENE BY LOW ENERGY ^4He IONS. Burns, W. G.; Marsh, W. R. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 2375-88(Sept. 1968).

Liquid benzene was irradiated at 20°C with ^4He ions of energy 7 down to 0.1 MeV, and yields of hydrogen, and in some cases, of acetylene, biphenyl, and polymer were measured. No abrupt changes of the instantaneous $G(H_2)$ value, defined as $d(G(H_2)E)/dE$, were observed when the energy E was varied, but a smooth rise to a maximum of 0.48 at the maximum LET (-dE/dx) was found. Since the graph of LET against energy has a maximum (the Bragg maximum) at ~0.5 MeV, LET 24.4 eV/Å, it is possible to have two ^4He ions of the same LET, one with energy above, the other with energy below that of the Bragg maximum. Higher instantaneous G values were found below the Bragg maximum than above it for ^4He ions of the same LET. It is possible to account for this effect in terms of the deposition of energy by associated electrons, as the higher energy particle produces a greater abundance of higher energy electrons, of low LET. Using calculations of the energy deposited by the heavy particle and by associated electrons in stated energy intervals, results were expressed in terms of the local instantaneous G value, i.e., the G value of the particle due to energy deposition in events of energy up to a limit η; these were correlated with the local LET, the linear rate of energy loss in such events. The experimental and derived curves of G values against LET were compared with those obtained from the Ganguly/Magee model with a mechanism involving the formation of product by the interaction of excited species, in competition with collision deactivation. Values of $G(H_2)$ for protons and ^7Li particles, both having lower charge than ^4He ions, were higher than $G(H_2)$ for ^4He ions at the same LET. The G values for the other products are compared with previous values. (auth) (UK)

239 PULSE RADIOLYSIS OF AQUEOUS THIOCYANATE AND IODIDE SOLUTIONS. Baxendale, J. H.; Bevan, P. L. T.; Stott, D. A. (Univ. of Manchester, Eng.). Trans. Faraday Soc., 64: 2389-97(Sept. 1968).

The transient absorption produced by the pulse radiolysis of CNS^- is shown to be due to $(CNS)_2^-$ formed by the reactions: $OH + CNS^- \rightarrow OH^- + CNS$, $CNS + CNS^- \rightleftharpoons (CNS)_2^-$. The rate constants of reactions (1), (2) and (3) at 22°C determined from kinetic and equilibrium measurements are 2.8×10^{10}, 7.0×10^9 M^{-1} sec^{-1} and 3.4×10^4 sec^{-1}, respectively. For iodide ion, which forms I_2 in the same way, the equilibrium constant for I_2 formation is 1.13×10^5 M^{-1}. The corresponding kinetic constants cannot be determined as accurately as for CNS^- but are estimated to be 3.4×10^{10}, 7.6×10^9 M^{-1} sec^{-1} and 6×10^4 sec^{-1}. (auth) (UK)

240 REACTIVITY OF HYDROGEN ATOMS WITH Fe^{3+}, $FeOH^{2+}$ AND Cu^{2+} IN AQUEOUS SOLUTIONS. Baxendale, J. H.; Dixon, R. S.; Stott, D. A. (Manchester Univ., Eng.). Trans. Faraday Soc., 64: 2398-2401(Sept. 1968).

The relative rate constants for the reactions of hydrogen atoms with Fe(II), Cu(II), and methanol, were obtained over a range of pH. Fe(III) reacts entirely as $Fe(OH)^{2+}$ and there is no measurable contribution from Fe^{3+} even in 0.2N perchloric acid. The ratio of rate constants are: $MeOH : FeOH^{2+} : Cu^{2+} :: 1 : 480 : 38$, and $k_{FeOH^{2+}} \gg 500\ k_{Fe^{3+}}$. (auth)

241 ISOTOPIC EXCHANGE AND SZILARD–CHALMERS REACTION IN BIS-(DIMETHYL GLYOXIMATO) DIAMMINE–COBALT(III) COMPLEXES IN THE SOLID STATE. Ramshesh, V. (Bhabha Atomic Research Centre, Trombay, India). pp 145-50 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Isotopic exchange and Szilard–Chalmers reaction in bis-(dimethylglyoximato) diammine–cobalt(III) nitrate and the corresponding chloride (hydrated and anhydrous) were investigated. Both complexes show little isotopic exchange with radio-Co^{2+}. After the radioactive capture of neutrons the nitrate and anhydrous chloride have low initial retentions and show only a small amount of thermal annealing. The chloride pentahydrate shows a high initial retention and a fair amount of thermal annealing. Two mechanisms viz., "variable depth electron trapping isotopic exchange model" and "hot zone model" were considered for interpretation of the data. These complexes seem to fall in the so-called "open-type" category. (auth)

242 STUDIES ON ^{60}Co SENSITISED LUMINESCENCE OF SCINTILLATOR SOLUTION IN BENZENE AND ITS QUENCHING BY METAL ACETYLACETONATES. Kalantri, O. P.; Srivastava, S. B. (Bhabha Atomic Research Centre, Trombay, India). pp 151-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Various metal acetylacetonates (10^{-2}M to 10^{-5}M) were employed to study the quenching of γ-induced luminescence of benzene solution of p-terphenyl. It was observed that cobalt and iron acetylacetonates are better quenchers than aluminum acetylacetonate. Further more aluminum acetylacetonate is observed to give a linear Stern–Volmer plot whereas in the other two cases it is concave in nature. A number of parameters like γ_s (solvent quenching constant), γ_0 (quenching constant at zero scintillator concentration), k_{sq} (specific rate of quenching), and τ (life time of donor species) were evaluated. Typical values of k_{sq} were found to be $>10^{10} M^{-1}$ sec^{-1}, which is indicative of resonance transfer of energy. (auth)

243 FORMATION OF CHARGED SPECIES IN THE (n,γ) RADIOLYSIS OF IODOBENZENE AND ETHYL IODIDE. Arnikar, H. J.; Sharma, D. K. (Univ. of Poona). pp 11-17 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Studies on the application of a dc electric field across silver electrodes in iodobenzene and ethyl iodide at different time intervals following their (n,γ) irradiation indicated the presence of charged species of either sign. The fraction of the total activity appearing as charged species was around 20 to 30%. A study of the variations in the conductivity of the irradiated systems with time indicated an initial rise within the first 3 to 5 minutes (the rise is faster in ethyl iodide) followed by a slow fall in the next 30 to 45 minutes. A probable mechanism is postulated based on slow isotope exchange reactions between the different charged, uncharged, active, and inactive species initially formed in the (n,γ) as well as in the gamma-radioinduced reactions. (auth)

244 EFFECT OF NITROUS OXIDE ADDITION ON THE HYDROGEN YIELDS IN THE γ RADIOLYSIS OF PYRIDINE AND PIPERIDINE. Rao, K. Narayana; Ramanan, G. (Bhabha Atomic Research Centre, Trombay, India). pp 18-26 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The contribution of solvated electrons, e^-_{sol}, to the G_{H_2} in pyridine and piperidine was studied. Nitrous oxide, which is an efficient electron scavenger, was added to pyridine and piperidine and G_{H_2} and G_{N_2} were determined. If H atoms are formed by the reactions $e^-_{sol} + RH \xrightarrow{k_1} RH^- \rightarrow R^- + H$, then nitrous oxide competes for e^-_{sol} according to $e^-_{sol} + N_2O \xrightarrow{k_2} N_2 + O^-$. A plot of $1/G_{H_2}$ vs $(RH)/N_2O$ should be linear, the intercept being $1/G_{e^-_{sol}}$. Similarly $1/G_{N_2}$ vs $1/(N_2O)$ also should be linear and the extrapolation to $1/(N_2O) = 0$ should give $1/G_{e^-_{sol}}$. The $1/G_{N_2}$ vs $1/(N_2O)$ plot is linear and gives in the case of piperidine $G_{e^-_{sol}} = 4.4$ and in the case of pyridine 0.33. But the $1/G_{H_2}$ vs $(RH)/(N_2O)$ does not give a straight line plot except at very low concentrations of N_2O. It is concluded from these that e^-_{sol} plays a very small part in the hydrogen formation from either pyridine or piperidine. (auth)

245 EFFECT OF γ RADIATION ON FURAN AND TETRAHYDROFURAN. Rao, K. N.; Goyal, G. C. (Bhabha Atomic Research Centre, Trombay, India). pp 27-36 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

In the gamma radiolysis of furan, the products hydrogen (G_{H_2} = 0.12), carbon monoxide (G_{CO} = 0.32), acetylene ($G_{C_2H_2}$ = 0.146), propylene ($G_{C_3H_6}$ = 0.035), and polymeric material (G polymer = 7.59) were identified. The polymeric material was investigated for its molecular weight and infrared spectra, showing an average molecular weight of 357 and the presence of a C=O group. In the case of tetrahydrofuran, yields of hydrogen (G_{H_2} = 3.28) and carbon monoxide (G_{CO} = 0.14) were independent of dose in the range 0.47×10^6 RAD to 10.1×10^6 RAD, whereas that of carbon dioxide shows a strong dose dependence. The products, methane, ethane, ethylene, propylene, cyclopropane, and propane were also estimated by mass spectrometry. The mechanisms for the formation of some of the products are discussed. (auth)

246 ISOTOPE EFFECT OF RECOIL ^{82}Br AND ^{80m}Br ATOMS UNDER (n,γ) PROCESS IN ETHYLENEDIBROMIDE. Shukla, B. M.; Mishra, S. P. (Banaras Hindu Univ., India). pp. 37-48 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Studies were made on the retention of ^{82}Br and ^{80m}Br recoil atoms in ethylenedibromide with varying concentrations (0 to 25 mole %) of elementary bromine as scavenger. Different retention values for ^{82}Br and ^{80m}Br recoil atoms were observed. They were dependent on the concentration of the added elementary bromine. It is anticipated that observed isotope effects between ^{80m}Br and ^{82}Br is due, mainly, to $^{82m}Br(IT)^{82}Br$ process. Results were discussed, and a scheme is suggested regarding the stabilization of recoil ^{82}Br and ^{80m}Br atoms. (auth)

247 PEROXIDE FORMATION IN THE RADIOLYSIS OF AQUEOUS HYDROCARBON SOLUTIONS. Shastri, L. V.; Srinivasan, Kamala; Rama Rao, K. V. S. (Bhabha Atomic Research Centre, Trombay, India). pp 49-57 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

When aqueous solutions of cyclohexane, methylcyclohexane, and trimethylpentane were irradiated with ^{60}Co gamma rays in the presence of air, hydrogen peroxide and typical organic peroxides were formed among other products. The respective yields of hydrogen peroxide and organic peroxides show a pH dependence, the former increasing and the latter decreasing with increasing acidity. It can be concluded from these results that the organic peroxide arises from a reaction of hydroperoxy radicals with organoperoxy radicals. A kinetic analysis of the data indicates that the basic form of hydroperoxy radical is much more reactive with $C_6H_{11}O_2$ than the acidic form. The pK of HO_2 radical is evaluated to be about 4 in good agreement with the pulsed radiolysis work. (auth)

248 RADIATION CHEMISTRY OF FROZEN AQUEOUS SYSTEMS. Gopinathan, Chakrapany (Bhabha Atomic Research Centre, Trombay, India). pp 100-6 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The radiation chemistry of aqueous acid and alkaline glasses

was investigated. Product analysis, visible and ultraviolet spectroscopy, and ESR measurements showed that mobile electrons are produced, which may be trapped or may react with acid groups or added solutes. From an examination of the thermal decay of trapped electrons at various temperatures, it was concluded that the primary radiation-produced electron migrates a distance of not more than 185 Å from its parent site and that it always returns to its parent site for neutralization. (auth)

249 APPLICATION OF ELECTRON SPIN RESONANCE IN THE STUDY OF THE γ RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS. Moorthy, P. N. (Bhabha Atomic Research Centre, Trombay, India). pp 107-20 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

The ESR technique was employed to study the paramagnetic species formed by the action of gamma radiation on ice and frozen aqueous solutions. The results are explained on the basis of the hypothesis that mobile electrons and holes are the primary transient species formed in these systems during gamma irradiation and that these species react with the solutes present to produce secondary, more stable species that are identifiable by their ESR spectra. Thus the mobile electrons were found to react with acidic solutes to form H atoms, and with group II(b) metal ions to give the corresponding univalent radical ions. The mobile holes, on the other hand react with anions such as SO_4^{-2}, $H_2PO_4^-$, and ClO_4^- to give SO_4^-, HP_4^-, and ClO_4. It was also found that the mobile electron and hole could be generated photochemically in presence of suitable sensitizing solutes, viz I^- and Fe^{+2} for the electron and Ce^{+4} for the hole, and these species are analogous to their gamma-produced counterparts in their reactions with solutes. (auth)

250 ESR STUDY OF IRRADIATED ISOTACTIC POLY (PROPYLENE OXIDE). Bhattacharyya, P. K.; Dole, M. (Northwestern Univ., Evanston, Ill.). pp 121-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

The ESR spectrum of gamma-irradiated poly(propylene oxide) was studied. The irradiation was carried out with a 1200-Ci ^{60}Co source at liquid nitrogen temperature in vacuum with a total dose of 15.4 MRAD. Radicals responsible for the spectrum are discussed. (M.C.G.)

251 ROLE OF DEHYDRATION AND REHYDRATION IN THE ANNEALING OF CHEMICAL RADIATION DAMAGE. Khare, M.; Mohanty, S. R. (Banaras Hindu Univ., India). pp 129-33 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

Loss of water of crystallization from gamma-irradiated calcium bromate monohydrate when heated above the dehydration temperature and uptake of water of crystallization by gamma-irradiated anhydrous calcium bromate result in considerable recovery of the damage. But, whereas following dehydration there is very little thermal recovery, the annealing behavior of the rehydrated material is quite normal below the dehydration temperature. The results are interpreted in terms of lattice reconstruction occasioned by dehydration and rehydration. (auth)

252 EFFECT OF RADIATION ON THE THERMAL DECOMPOSITION OF CRYSTALLINE LEAD NITRATE. Mohanty, S. R.; Ray, M. N. (Banarus Hindu Univ., India). pp 134-40 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

The role of defects generated by irradiation in the thermal decomposition of crystalline lead nitrate was investigated. The decomposition follows the Prout–Tompkins law. Irradiation enhances the decomposition rate and the effect increases with dose. The activation energies are, however, not appreciably affected by irradiation. Post-irradiation annealing tends to restore the decomposition characteristics of the original unirradiated substance. It was considered that irradiation produces chemical damage giving rise to species that constitute the decomposition nuclei and are responsible for the higher thermal decomposition of the irradiated crystals. (auth)

253 EVIDENCE FOR IONIC PROCESSES IN IRRADIATED POLYMERS. CROSSLINKING OF 4-POLYVINYLPYRIDINE AT LOW TEMPERATURE. David, C.; Verhasselt, A.; Geuskens, G. (Univ. of Brussels) Polymer, 9: 521-6(Oct. 1968).

The influence of various additives on the radioinduced crosslinking of 4-polyvinylpyridine was studied. Only strong electron acceptors increase gel formation at 77°K and were an influence on the ESR spectra of the irradiated polymer. These results demonstrate the occurrence of ionic processes. (auth) (UK)

254 FORMATION OF PAIRS OF RADICALS DURING THE RADIOLYSIS AND PHOTOLYSIS OF ORGANIC PEROXIDES. Zubkov, A. V.; Koritskii, A. T.; Lebedev, Ya. S. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR, 180: 1150-3 (June 11, 1968). (In Russian).

During the photolysis or radiolysis of organic peroxides only the usual electron paramagnetic resonance signals of the isolated radicals have been observed. In order to obtain additional information on pairs of radicals, the EPR signals obtained during the uv photolysis and radiolysis of organic peroxides and their hydrates were analyzed. The investigated materials included acetyl benzoyl peroxide, benzoyl peroxide, dicumyl peroxide, diphenylethyl hydroperoxide, and others. The results indicated that at least in the case of diphenylethyl hydroperoxide, pairs of radicals are formed. Valuable information was obtained about the mechanism of photo- or radiochemical reactions involved in these processes. The photolysis was carried out at 77°K, while a fast electron accelerator was used for radiolytic studies. The EPR spectra were recorded at either 77°K or at temperatures up to 300°K. It was found that the photodecomposition of the organic peroxides in the solid state leads to the formation of unstable pairs of radicals. Similar pairs are also formed during the data radiolysis of organic compounds. (TTT)

255 AN ESTIMATION OF THE PROPAGATION RATE CONSTANT FOR THE RADIATION-INDUCED POLYMERIZATION OF GASEOUS ISOBUTENE. Noro, Yasuyuki; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). Bull. Chem. Soc. Jap., 41: 1737(July 1968).

The propagation rate constant and the mean lifetime of the propagating ion were estimated in a quantitative study of the effects of ammonia on the radioinduced polymerization of gaseous isobutene(2-methylpropene). (J.G.B.)

256 HOT ATOM CHEMISTRY OF PHOSPHORUS COMPOUNDS. II. CHEMICAL EFFECTS OF NEUTRON IRRADIATION ON PHOSPHORIC ESTERS OF HEXOSES. Kiso, Yoshiyuki; Kobayashi, Mitsue; Kitaoka, Yoshinori; Kawamoto, Keizo; Takada, Jitsuya (Kyoto Univ.). Bull. Chem. Soc. Jap., 41: 1642-7 (July 1968).

Phosphoric esters of hexoses were subjected to neutrons and the resulting ^{32}P-labeled recoil products were separated by paper chromatography and paper electrophoresis. The main recoil products were phosphorous and phosphoric acids, independent of the chemical form of the target material and the kind of its salt. A small amount of inorganic acids containing a P–P or P–O–P bond was also found. The yield of the retention product was less than a few percents. The presence of organic diphosphorus compound was supposed by paper electrophoretic analysis. An addition of a small amount of water to the target material before irradiation favored formation of ^{32}P-labeled phosphorus oxyacids in lower oxidation state. The results from irradiation of aqueous solution gave an unexpected chromatographic behavior owing to some unstable complex of recoil ^{32}P atom with water molecule. (auth)

257 OXIDES AND OXYIONS OF THE NONMETALS. PART X. THE BO_3^{2-} IMPURITY CENTRE IN IRRADIATED CALCIUM CARBONATE. Eachus, R. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A, No. 10, 2438-41 (1968).

The radical BO_3^{2-}, formed by the action of γ rays on calcium carbonate doped with borate anions, was identified by its ESR and optical absorption spectra. The principal values of the g- and a-tensors are $g_{||} = 2.0080$, $g_{\perp} = 2.0127$, $a_{||} = -12.6$ gauss, and $a_{\perp} = -8.3$ gauss. The structure and mechanism of formation of this center are discussed, and a comparison made with the isoelectronic radicals CO_3^- and NO_3. (auth) (UK)

258 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED SINGLE CRYSTALS OF AROMATIC COMPOUNDS. PART III. 2,6- AND 2,4-Di-t-BUTYLPHENOL. Atherton, N. M.; Harding, R. S. F. (Univ. of Sheffield, Eng.). J. Chem. Soc., A, No. 10, 2352-3(1968).

The ESR spectra of substituted phenoxyl radicals trapped in γ-irradiated crystals of 2,6- and 2,4-di-tert-butylphenols are described and discussed. (auth) (UK)

259 THE PREPARATION OF ^{60}Co WITH THE HELP OF ALUMINOSILICATES. Ghosh, A. R. (Indian Inst. of Tech., Kharagpur); Henry, R.; Beydon, J. pp 286-92 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

Three different aluminosilicates, namely synthetic Zeolite, specially treated Montmorillonite and Kaolinite having different orders of base exchange capacities were exchanged with cobalt ions, and subjected to neutron flux of 10^{19}. A part of the Co-aluminosilicates was heated at 350°C and washed with 10^{-3}N HCl before irradiation. Subsequently the cobalt ions were eluted by solutions of different acidity. ^{60}Co activity in each fraction was found by gamma-spectrometry and total cobalt determined by neutron activation and thus the enrichment factors and yields (activities compared with a standard) were calculated. There is practically no enrichment for the non-heated samples. The enrichment factor for heated samples eluted with water is the same for all the aluminosilicates (nearly 4.2). However, the enrichment factor decreases with increasing acidity of the eluting agent, but markedly in different degrees for the three aluminosilicates. However there is considerable difference in behavior among the aluminosilicates with respect to yield. Heated synthetic Zeolite, finally eluted with 10^{-3}N HCl gives the best result considering both enrichment factor and yield. Some attempt was made to correlate the results broadly with the structure of aluminosilicates and the process of preparation of the radioelement. (auth)

260 THERMOLUMINESCENCE AND PHASE TRANSITIONS OF IRRADIATED FLUORINATED POLYMERS. Mele, A.; Delle Site, A.; Bettinali, C.; Di Domenico, A. (CNEN, Rome. Univ., Rome). J. Chem. Phys., 49: 3297-3302(Oct. 1, 1968).

Polytetrafluoroethylene and polytetrafluoroethylene oxide were irradiated under vacuum and in the presence of oxygen and helium. The thermoluminescence glow curves of the polymers were examined from liquid-nitrogen temperatures up to about 60°C. The polymers irradiated in vacuo show very weak thermoluminescence emission. The presence of gas during irradiation has the effect of inducing a strong emission. The temperature of the thermoluminescence peaks coincides with the appearance of molecular motions. The spectral distribution of the thermoluminescence glow peaks was determined. The results were interpreted on the basis of the electron-trap theory. It is suggested that thermoluminescence at low temperature is associated with a continuous structural change in the amorphous regions which occurs on warming the polymers and that the trapping levels are uniformly distributed over a wide range of energy. The thermoluminescence glow peaks near room temperature correspond to well-defined crystalline transitions in the two polymers. (auth)

261 ELECTRON PARAMAGNETIC RESONANCE OF X-RAY-IRRADIATED SINGLE CRYSTALS OF POTASSIUM COBALTICYANIDE, $K_3Co(CN)_6$. Lin, W. C.; McDowell, C. A.; Ward, D. J. (Univ. of British Columbia, Vancouver). J. Chem. Phys., 49: 2883-6(Oct. 1, 1968).

X-ray irradiation of single crystals of undoped diamagnetic potassium cobalticyanide $K_3Co(CN)_6$ was shown to produce paramagnetic species. The electron paramagnetic spectra indicate that the eight-line hyperfine interactions observed ($I = 7/2$ for ^{59}Co) collapse into one set when the magnetic field is parallel to any one of the three crystallographic axes labeled a, b, or c. The widths of the hyperfine lines vary and the linewidths increase as the values of the nuclear magnetic spin quantum number (M_I) decreases. The experimental results were interpreted in terms of an appropriate spin Hamiltonian to yield the principal values of the axially symmetric g and hyperfine interaction tensor A. The results obtained are $g_{||} = 2.010 \pm 0.005$, $g_{\perp} = 2.170 \pm 0.005$; $A_{||} = 83.5 \pm 2$ G, and $A_{\perp} = 26.9 \pm 2$ G. A theoretical estimate of the g values obtained by using the method described by Pryce leads to the conclusion that the paramagnetic center is most likely due to a species with d^7 configuration formed by the odd electron going into a d_{z^2} orbital followed by a weak tetragonal distortion to symmetry D_{4h} of the ensuing structure as the result of the Jahn–Teller effect. An alternative possibility is that the original anion loses a CN group to form a paramagnetic species with symmetry C_{4v}. (auth)

262 FIELD ION MICROSCOPE EXAMINATION OF HEAVY ION RADIATION DAMAGE IN IRIDIUM. I. EXPERIMENTAL TECHNIQUE. Hudson, J. A. (Cambridge Univ., Eng.); Nelson, R. S.; Ralph, B. Phil. Mag., 18: 839-45(Oct. 1968).

The investigation of heavy ion radiation damage in iridium by field-ion and electron microscopy is discussed. An experimental arrangement is described in which prepared field ion microscope specimens may be bombarded in situ by ions from a heavy ion accelerator. Some early results are described for specimens bombarded with Ar^+ and Xe^+ ions in the 50 to 100 keV energy range at liquid nitrogen and room temperatures. (auth) (UK)

263 ESR AND OPTICAL STUDIES OF ACYL RADICALS PRODUCED FROM ACYL CHLORIDES BY DISSOCIATIVE ELECTRON ATTACHMENT IN γ-IRRADIATED ORGANIC GLASSES AT 77°K. Noda, Shoji; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan) J. Chem. Phys., 49: 3287-92(Oct. 1, 1968).

Dissociative electron attachment by acyl chlorides in γ-irradiated organic glasses at 77°K was investigated by ESR and optical absorption measurements. The 2-methyltetrahydrofuran (MTHF) and 3-methylpentane (3MP) glasses containing acyl chlorides (CH_3COCl, C_2H_5COCl, $C_6H_5CH_2COCl$, C_6H_5COCl, C_6H_5CH = $CHOCl$) display a similar ESR singlet. 3-Methylpentane glass containing CH_3COCl exhibits an ESR singlet or triplet depending upon solute concentration. γ-irradiated MTHF glasses containing these solutes give the optical absorption spectra having the characteristic absorption bands in the visible and uv region. These ESR and optical absorption spectra were assigned to acyl radicals. Illumination of γ-irradiated samples with visible light yields alkyl radicals from $CH_3CO\cdot$ and $C_2H_5CO\cdot$, benzyl radicals from $C_6H_5CH_2CO\cdot$, and brings about no change in $C_6H_5CO\cdot$ and $C_6H_5CH = CHCO\cdot$. The decay of alkyl radicals formed in 3MP was measured at 77°K. (auth)

264 IMPROVEMENTS IN OR RELATING TO THE CURING OF SURFACE-COATING COMPOSITIONS. McCausland, Robert James (to Berger, Jenson, and Nicholson Ltd.). British Patent 1,128,971. Oct. 2, 1968. Filed June 30, 1965.

A method is described for curing a polyester-based surface-coating composition by irradiating the uncatalyzed composition with a high-energy electron beam at an energy level of at least 0.4 MeV. The composition is made up of the polyester and an unsaturated hydrocarbon or ester copolymerized with the polyester. (B.L.M.)

265 METHOD FOR PRODUCING ALCOHOLS CONTAINING FLUORINE WITH AN UNSATURATED FIVE-MEMBER RING. Muramatsu, Hiroshinge (to Chief of the Agency of Industrial Science and Tech.). Japanese Patent 1968-3776. Feb. 12, 1968. Filed Nov. 6, 1964.

A mixture of 1,2-dichlorohexafluorocyclopentene and alcohol of the general formula RR'CHOH (where R, R' are hydrogen atoms or an alkyl group with 1 to 4 carbon atoms) is irradiated with γ rays to obtain the alcohol containing fluorine with a chlorohexafluorocyclopentenyl group. (NSA of Japan)

266 STUDIES IN RADIATION POLYMERIZATION. IX. RADIATION POLYMERIZATION OF N-p-NITROPHENYLMALEIMIDE. Ivanova, V. S.; Smirnova, V. K.; Kalandaze, I. R. Vestn. Leningrad. Univ., Ser. Fiz. Khim, 142-5(Feb. 1968). (In Russian).

N-p-nitrophenylmaleimide (N-p-NPMI) was synthesized and its radiation polymerization by γ rays from ^{60}Co in solid and liquid states was investigated. N-p-NPMI polymerized with difficulty. The polymer was characterized by solubility, intrinsic viscosity, ir spectra, and by temperatures of softening and decomposition. (auth)

267 ELECTRON AND RADICAL SCAVENGING BY ACRYLAMINE, m_1, IN AQUEOUS SOLUTION. Chambers, K. W.; Collinson, E.; Dainton, F. S. (Univ. of Leeds, Eng.). Chem. Commun., No. 20, 1250-1(1968).

Absolute rate constants for the reaction of m_1 with e^-_{aq}, OH radicals, and H-atoms have been determined previously, and it was proposed that the species formed by reaction of e^-_{aq} with m_1, and responsible for the intense absorption at 275 mm observed in pulse radiolysis, was the radical anion $\cdot m_1^-$. Present studies indicate that the radical anion is rapidly protonated during the pulse to form the radical $\cdot m_1H$ of formula $CH_2\overset{\cdot\cdot\cdot}{\cdot}CH\overset{\cdot\cdot\cdot}{\cdot}C(OH)NH_2$, which has an absorption maximum for which $\epsilon_{275} = 7300 \pm 800$ M^{-1} cm^{-1}. Results are discussed and shown graphically for $G(\cdot m_1H)$ as a function of $[m_1]$, and for the variation of $G(Hm_1\cdot + HOm_1\cdot)$ with $[m_1]$. Previous observations that scavenging by m_1 of precursors of the "molecular" products H_2 and H_2O_2 occurs when $[m_1] > 10^{-3}$ are in accordance with the present results. (UK)

268 RADIOLYSIS OF LIQUID AND SOLID DIMETHYLMERCURY. Wolf, Clarence J.; Walker, John Q. (McDonnell Douglas Corp., St. Louis). J. Phys. Chem., 72: 3457-62(Oct. 1968).

The cobalt-60 γ radiolysis of liquid and solid dimethylmercury was investigated as a function of dose and irradiation temperature and in the presence of radical scavengers. The 100-eV yields of methane, ethane, ethylene, propylene, propane, elemental mercury, and methylethylmercury were determined at 28, 0, −21, −78, and −196°. The mechanism of the radiolysis reactions is discussed and it is compared with photolysis and thermal decomposition. (auth)

269 OXIDATION OF CERIUM(III) IN SULFURIC ACID SOLUTIONS INDUCED BY COBALT-60 γ RADIATION. Matthews, R. W.; Mahlman, H. A.; Sworski, T. J. (Oak Ridge National Lab., Tenn.). J. Phys. Chem., 72: 3704-5(Oct. 1968).

Studies were made on the radioinduced oxidation of Ce(III) in sulfuric acid solutions. The reaction mechanism for net Ce(III)

oxidation was established. Two distinguishable oxygen effects on the radiolysis of deaerated Ce(III) solutions were observed. Low initial concentration of oxygen increased the initial rate of Ce(III) oxidation such that $G(Ce(IV)) > 2G_{H_2}$. This effect of oxygen is oxidation of Ce(III) by H atom with concomitant decrease in oxygen concentration. An increase in oxygen concentration with increase in dose caused the Ce(IV) concentration to reach a maximum and then decrease to zero. (P.C.H.)

270 PULSE RADIOLYSIS OF BENZENE–BIACETYL SOLUTIONS. Cundall, R. B. (Univ., Notingham, Eng.); Evans, G. B.; Griffiths, P. A.; Keene, J. P. J. Phys. Chem., 72: 3871-7(Oct. 1968).

Phosphorescence emission from biacetyl has been used to study singlet and triplet excited states produced in the pulse radiolysis of benzene. Cyclohexene acted as a selective scavenger of the triplet state of benzene while the lowest excited singlet state was practically unaffected. The quenching of the benzene excited singlet and triplet states by biacetyl was effectively diffusion controlled and a lifetime of the order of 10^{-8} sec was derived for the excited benzene triplet. A species with an absorption maximum at 317 mμ had identical decay kinetics with the phosphorescence and was assumed to be the biacetyl triplet. Using this absorption and an extinction coefficient of 6400 M^{-1} cm^{-1}, it was concluded that in irradiated benzene the initially formed excited state yields are $G(^1B_{2u}) = 1.43$, $G(^3B_{1u}) = 1.24$ with a total measured excited-state yield of 2.67. Some observations were made on the quenching of the biacetyl triplet by cyclohexene ($k = 1.18 \times 10^5$ M^{-1} sec^{-1}). A free-radical quenching species was produced by radiolysis of the benzene and was formed from a species, probably ionic, which achieved a steady state during the pulse. The mechanism assumed involves energy transfer from the $^1B_{2u}$ and $^3B_{1u}$ (or corresponding excimers) states of benzene to the solute. The presence of higher excited states of benzene may explain the difference between the measured yields and values obtained in other experiments. (auth)

271 TRANSIENT SPECIES IN THE RADIOLYSIS OF SOLUTIONS OF STILBENE. Dainton, F. S.; Peng, C. T.; Salmon, G. A. (Univ. of Leeds, Eng.). J. Phys. Chem., 72: 3801-7(Oct. 1968).

When solutions of cis- and trans-stilbene in either benzene or cyclohexane were irradiated with 2-μsec pulses of 3-MeV electrons, absorption bands were observed in the uv (λ_{max} 360 nm) and visible (λ_{max} 480 nm in benzene and 500 nm in cyclohexane) regions. From the effects of additives such as O_2, N_2O, anthracene, and naphthalene, the uv absorption, which decayed in a first-order manner, was ascribed to a triplet state while the visible band, which decayed according to a second-order law, was attributed to the stilbene anion. Estimates were derived of the rate constants of some energy transfer processes. The results were consistent with radioinduced geometrical isomerization of stilbene in dilute solutions proceeding to a radiostationary state predominantly via triplet states and in concentrated solutions predominantly via ions or radicals to exclusively trans-stilbene. (auth)

272 FORMATION OF HYDROGEN IN THE PHOTOLYSIS OF DIBORANE AT 1849 A. Bufalini, Marijon; Todd, J. E. (Univ. of Cincinnati). J. Phys. Chem., 72: 3367-71(Oct. 1968).

The photolysis of low pressures of diborane, alone and in the presence of D_2, at 1849 Å was investigated. The products H_2, B_4H_{10}, and B_5H_{11} were measured as a function of time. A reaction mechanism based upon the primary steps $B_2H_6 + h\nu \rightarrow B_2H_6^*$, $B_2H_6 + h\nu \rightarrow B_2H_4 + H_2$, and $B_2H_6 + h\nu \rightarrow B_2H_5 + H$ is proposed, from which it can be calculated that $\Phi_4 : \Phi_5 : \Phi_6 = 0.17 : 0.12 : 1.0$. Thus the photodissociation of diborane into B_2H_5 and H is the predominant primary step, and the molecular elimination of H_2 in a primary photodissociation step appears to play only a minor role in the production of H_2. (auth)

273 AFTER EFFECT IN X-IRRADIATED AQUEOUS SOLUTIONS OF LYSIN AND OTHER ALIPHATIC AMINO ACIDS. Hussmann, Eckart (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 5: 132-44(1968). (In German).

Irradiated solutions of aliphatic amino acids or amines showed an after effect when the irradiated compounds had at least 3 C-atoms in their carbon-chains and the solutions contained oxygen. During the after-reactions the optical density increased between the wavelength 200 and 400 nm. Likewise an increasing fluorescence could be observed with a maximum at 450 nm in its emission-spectrum. Also the refractive index rose. These results and other investigations show a formation of heterocyclic compounds during and after-reactions. One or more atoms are N-atoms in the yielded ring. (auth)

274 RADIOLYSIS OF COLLOIDAL SULFUR. Donaldson, G. William; Johnston, Francis J. (Univ. of Georgia, Athens). J. Phys. Chem., 72: 3552-8(Oct. 1968).

Colloidal sulfur is solubilized in aqueous media upon absorption of ionizing radiation. The major product is sulfuric acid. Sulfur hydrosols having a narrow particle size distribution were irradiated and particle size changes followed by light scattering techniques. Under the experimental conditions used, the particles apparently react independently of one another and the G-value for the disappearance of sulfur in colloidal form increases with decreasing particle radius. The rate of reaction, in terms of sulfur atoms per particle, is $-dn_s/dt = Br^m$ with m varying from approximately 1 for particles of 0.40-μ radius to −1 for particle of 0.19-μ radius. Oxygen, hydrogen peroxide, ferrous ion, and bromide inhibit the reaction. The rate is increased by n-propyl alcohol. The results are not explained within the framework of homogeneous aqueous radiation chemistry and suggest that specific interfacial effects are important. (auth)

275 GAMMA RADIOLYSIS OF AQUEOUS SOLUTIONS OF ARYL ALKYL AMINES. Kabi, A.; Clay, P. G. (Imperial Coll. of Science and Tech., London). Radiat. Res., 34: 680-8(1968).

Irradiation of benzyltrimethylammonium ions in aqueous solutions resulted in deamination brought about by hydrated electrons. Trimethylamine was the major nitrogenous deamination product. The rate constant for the reaction with electrons, established by competition kinetics, was $k_s = (0.95 \pm 0.27) \times 10^{10}$ liter $mole^{-1}$ sec^{-1}. In concentrated solution (>10^{-2} M), $G(Me_3N)$ was significantly higher than $G_{e^-_{aq}}$. Radioinduced deamination of benzyldimethylamine was also observed. Reductions in yield of dimethylamine, the deamination product, were brought about by the addition of electron scavengers, but the magnitudes of these reductions were not in accord with simple competition kinetics. (auth)

276 ANALYSIS OF THE RECOIL PRODUCTS IN NEUTRON IRRADIATED PHENYLARSENIC COMPOUNDS. PART 1. MONO-, DI-, AND TRIPHENYLARSENIC COMPOUNDS. Grossmann, G.; Zeuner, A. (Technical Univ., Dresden). Isotopenpraxis, 4: 215-19(June 1968). (In German).

A separation method permitting determination of the yields of activities was elaborated for mono-, di-, and triphenylarsenic compounds as well as for nonorganically bound arsenic in neutron-irradiated phenylarsenic compounds. Several compounds having the same quantity of phenyl-groups related to one arsenic atom underwent an oxidation or a reduction process to obtain a defined form. Extraction, ion exchange, and chromatography on Al_2O_3 were used as the separation methods. Utilizing the principle of isotope dilution analysis, crystallization, or precipitation, reactions were employed for purification and yield determination of di- and triphenylarsenic products. The separation scheme for the preparation of the following irradiated compounds is given: $PhAsH_2$, Ph_2AsH, Ph_3As, $(PhAs)_6$, $(Ph_2As)_2$, PhAsO, $(Ph_2As)_2O$, $PhAsO(OH)_2$, $Ph_2AsO(OH)$, Ph_3AsO. (auth)

277 EXPERIMENTAL INVESTIGATIONS OF CHEMICAL EFFECTS ASSOCIATED WITH NUCLEAR TRANSFORMATIONS IN SOME INORGANIC SOLIDS. Andersen, T. Aarhus, Denmark, Aarhus Univ., 1968. 95p.

Thesis.

Chemical effects of nuclear transformations in inorganic solids were studied with emphasis on oxyanion systems; it was shown that they are closely related to radiolytic phenomena. Radiolytic fragments in irradiated alkali metal bromates were identified by chemical and physical methods; fragments produced in neutron-irradiated potassium chromate were identified by a chemical analysis based on dissolution of the sample in chromo-peroxy-chlorate solutions; neutron-irradiated magnesium stannate was investigated by chemical analysis and Moessbauer spectroscopy. The mechanisms of formation of radiolytic fragments by nuclear recoil, especially in inorganic solids, are reviewed. Different types of annealing reactions are described, and a new mechanism for thermal annealing is proposed. It is shown that thermal annealing can be initiated by pressure, which leads to crystal defects. (Denmark)

278 YIELD OF FREE IONS IN IRRADIATED LIQUIDS; DETERMINATION BY A CLEARING FIELD. Schmidt, Werner F.; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 72: 3730-6(Oct. 1968).

A new method is described for determining the yield of free ions formed by irradiation of a liquid. Yield values are reported for 19 pure liquids at room temperature, for three liquids over a range of temperatures, and for two mixtures over the complete range of compositions. The results are discussed in terms of the mean distances that electrons, formed by ionization, can penetrate into the liquid before becoming thermalized. The free-ion yields in the various liquids show much more variation than anticipated; thus the yield in neopentane is six times as great, and the penetration distance two and one-half times as great, as in normal pentane. The reason for these variations is far from obvious. (auth)

279 ABSORPTION SPECTRA AND KINETICS OF HYDROGEN SESQUIOXIDE AND THE PERHYDROXYL RADICAL. Bielski, Benon H. J.; Schwarz, Harold A. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 72: 3836-41(Oct. 1968).

An absorption spectrum below 280 mμ attributable to hydrogen sesquioxide was found in the pulse radiolysis of air-saturated perchloric acid solutions. The decay of the spectrum is in agreement with previous results obtained by reaction of the H_2O_3 with ferrous sulfate in a flow system. The activation energy for the decomposition at pH 2 is 16.5 kcal/mole. The maximum half-life for H_2O_3 in aqueous solution is 17 sec in 0.027 M acid and at 0°. Neither the absorption spectrum nor the decay kinetics that we find for the perhydroxyl radical offer any support for the existence of the protonated form, $H_2O_3^+$. (auth)

280 PULSE-RADIOLYSIS AND FLASH-PHOTOLYSIS STUDY OF AQUEOUS SOLUTIONS OF SIMPLE PYRIMIDINES. URACIL AND BROMOURACIL. Danziger, R. M.; Hayon, E.; Langmuir, M. E. (Pioneering Research Lab., Natick, Mass.). J. Phys. Chem., 72: 3842-9(Oct. 1968).

The pulse radiolysis of uracil and 5-bromouracil was studied at pH 1.0, 5.5, and 11.0 in argon-, air- and N_2O-saturated aqueous solutions. The main precursor which gives rise to the observed transient optical absorption spectra in these systems was the OH radical. The transient species, which decay according to the second-order rate law, are considered to be formed from the addition of OH radicals to the 5,6 double bond of the pyrimidine molecule. In the flash photolysis of neutral and acidic solutions of 5-bromouracil, two major transients are produced with λ_{max} at 320 nm and 420 nm which decay by second-order processes. One of the main primary photolytic processes is homolytic cleavage of the C–Br bond to produce Br radicals, as evidenced by the formation of Br_2^- radical anions on photolysis in the presence of bromide ions. Photolysis of the bromouracil anion (RO^-) in air-free alkaline solution produces two major species with absorption maxima at 330 and 420 nm. The "330" transient appears to result from the photoionization of RO^- to $RO\cdot + e^-_{aq}$. A similar RO· transient species is formed in the pulse radiolysis of alkaline air-free aqueous solutions of RO^- ions, produced by abstraction of an electron from RO^- by OH radicals. (auth)

281 PULSED-RADIOLYSIS STUDY OF ATOMIC OXYGEN REACTIONS IN THE GAS PHASE. Meaburn, G. M.; Perner, D.; LeCalve, J.; Bourene, M. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). J. Phys. Chem., 72: 3920-5(Oct. 1968).

The techniques of pulsed radiolysis, with spectroscopic detection of transients, was used to study some gas-phase reactions of atomic oxygen produced in electron-irradiated CO_2, N_2O, and CO at pressures close to 1 atm. In the presence of small amounts of added O_2, oxygen atoms are removed from these systems mainly by the three-body reaction, O(triplet) + O_2 + M → O_3 + M. The formation of ozone is found to follow pseudo-first-order kinetics in all three cases with rate constants k = 3.7, 3.2, and 1.6×10^8 M^{-2} sec^{-1}, respectively, for M = CO_2, N_2O, and CO. Kinetic analysis of ozone formation in O_2 indicates the occurrence of two parallel reactions in this system: O(triplet) + O_2 + O_2 → O_3 + O_2, and O(singlet) + O_2 → O(triplet) + O_2. The rate constant for the deactivation reaction was established to be 9.8×10^6 M^{-1} sec^{-1}. Mixtures of CO_2, O_2, and chloromethanes were also studied and various transient spectra identified, including those of the radicals ClO and CCl. In particular, the relative concentrations of these intermediates were determined in the three-component system CO_2–O_2–CCl_4. The experimental observations are explained in terms of competition between CCl_4 and O_2 for an undefined excited state of CO_2, with the resulting energy transfer processes yielding CCl and O(singlet), respectively. Reaction of O(singlet) with CCl_4 leads to the eventual formation of ClO in these mixtures. (auth)

282 GAS-PHASE PHOTOLYSIS OF CYCLOHEXANE IN THE PHOTOIONIZATION REGION. Ausloos, P.; Rebbert, R. E.; Lias, S. G. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 72: 3904-14(Oct. 1968).

The photolysis of cyclohexane (IP = 9.88 eV) was studied in the gas phase using 1470-Å (8.4 eV), 1236-Å (10.03 eV), and 1067 to 1048-Å (11.6 to 11.8 eV) radiation. At the latter two wavelengths, ions and superexcited molecules are formed. Emphasis is placed on the measurement of accurate quantum yields at all three wavelengths through both chemical actinometry and saturation current measurements. The primary decomposition of the excited cyclohexane molecule, $c\text{-}C_6H_{12}^* \rightarrow C_6H_{10} + H_2$, reported earlier for the photolyses at 8.4 and 10.03 eV, is also seen to occur at 11.6 to 11.8 eV. In addition, evidence is presented for ring opening and rearrangement of the excited hexamethylene intermediate, followed by decomposition to form alkyl radicals. At 1470 Å, secondary decompositions of excited intermediates are readily quenched by an increase in pressure, the quenching being more effective for deuterated than for nondeuterated species. On the other hand, little or no pressure effect on product formation is observed in the photolysis at 1067 to 1048 Å. In the photolysis at 1067 to 1048 Å, the parent cyclohexane ions have sufficient energy to undergo fragmentation processes, but it is demonstrated that fragmentation is negligible at pressures above 1 torr. Using the photoionization results, it is also demonstrated that in the radiolysis, the ion pair yield of the cyclohexane parent ion is 0.3 at 13 torr and 0.34 at 90 torr. Assuming that the fragmentation of the excited cyclohexane molecule observed in the photolysis at 11.6 to 11.8 eV is roughly representative of the superexcited molecule dissociation which occurs in the radiolysis, the 1067 to 1048-Å photolysis product yields are used to derive a value for the ratio of neutral excited molecules to ion pairs formed in the radiolysis. This ratio is 0.1 to 0.3. (auth)

283 REACTIONS OF IONS IN THE RADIOLYSIS OF LIQUID ISOBUTANE, ISOPENTANE, AND 2,3-DIMETHYLBUTANE. Tanno, Kuniyasu (Tokyo Inst. of Tech.); Shida, Shoji; Miyazaki, Tetsuo. J. Phys. Chem., 72: 3496-3503(Oct. 1968).

The reactions of ions, especially fragmentation of excited ions and the subsequent reactions of fragment ions, in the radiolysis of liquid isobutane, isopentane, and 2,3-dimethylbutane have been studied by using charge scavengers such as sulfur hexafluoride and ammonia. The yields of sec-$C_3H_7^+$ have been measured with the result of G = 1.15, 0.23, and 0.5 for the radiolysis of isobutane, isopentane, and 2,3-dimethylbutane, respectively. The existence of $C_4H_9^+$ has also been confirmed in the radiolysis of isopentane. These ions react with electrons to form propylene or butene in the absence of an additive. The hydride ion transfer reaction between sec-$C_3H_7^+$ and the parent molecule appears to be slower than that simply expected from the results observed in the gas phase. The yields of neutralization of parent ions giving fragment products become larger as the number of carbon atoms in the hydrocarbons increases. The ion–molecule reaction sec-$C_3H_7^+ + NH_3 \rightarrow C_3H_6 + NH_4^+$ occurs even in the liquid phase. In the radiolysis of isopentane, above 85% of the total ionization yield has been able to be accounted for by the observed G-values of ionic reactions. (auth)

284 PULSE RADIOLYSIS OF AQUEOUS SOLUTIONS OF THYMINE AND TRIACETONEAMINE N-OXYL. Emmerson, Peter T. (Yale Univ., New Haven); Willson, Robin L. J. Phys. Chem., 72: 3669-71(Oct. 1968).

Studies were made on the reaction between a radioinduced free radical from thymine and the organic nitroxide free radical, triacetoneamine N-oxyl (TAN). Solutions of thymine were saturated with N_2O (2×10^{-2} M) and irradiated with 0.2-μsec pulse of electrons giving a dose of approximately 2 kRads. Oscilloscope traces are given to show the effects of TAN on the decay of the absorption at 400 mμ produced by pulse-irradiating aqueous solutions of thymine (6×10^{-4} M) at pH 5.5. It was found that in the presence of low concentrations of TAN, the OH radicals will still react principally with thymine. The results showed that the transient absorption decayed much more rapidly in the presence of TAN. Reaction mechanisms are discussed. (P.C.H.)

285 ENERGY TRANSFER IN RADIOLYSIS OF RARE GAS–PROPANE LIQUID MIXTURES. Koob, R. D.; Kevan, Larry (Univ. of Kansas, Lawrence). J. Phys. Chem., 72: 3808-14(Oct. 1968). (COO-1528-22).

The γ radiolysis of Xe, Kr, or Ar–C_3H_8 liquid mixtures has been investigated in the presence and absence of O_2 as a radical scavenger. The yields of ionic and excited molecule reactions have been assessed by isotopic analysis of C_3H_8–C_3D_8–O_2–rare gas and $CH_3CD_2CH_3$–O_2–rare gas irradiated mixtures. These yields have been related to the nature and efficiency of the energy transfer process by comparison with detailed radiolysis and photolysis results for pure liquid propane. Phase effects have been analyzed by comparison with gas-phase data. In xenon mixtures the gas–liquid phase change decreases ionic decomposition by 71% and excited molecule decomposition by only 8%, but in krypton mixtures both ionic and excited molecule decomposition yields were similar in gas and liquid phases. In liquid mixtures propane decomposition due to ionic fragmentation was 93, 76, and 39% in Ar, Kr, and Xe mixtures, respectively. The excited molecule fragmentation products showed that the average energy of the excited molecule was high and about constant in Ar, Kr, and Xe mixtures. It was concluded that ion neutralization produces most of the excited molecules and that charge transfer from rare gas ions is the predominant energy transfer process. Overall energy transfer efficiencies in nonscavenged systems follow the trend: Xe > Kr > Ar. (auth)

286 INTERACTIONS OF FISSION PRODUCT ATOMS WITH METAL ACETYLACETONATES. Meinhold, H.; Reichold, P.

(Hahn-Meitner-Institut, Berlin). Naturwissenschaften, 55: 344-5(July 1968). (In German).

Powdered acetylacetonates of Co, Al, Cr, Fe, and Rh were mixed with a uranium compound and irradiated. The Co complex was first tested as a captor of the recoil fission product atoms formed. Fission isotopes of Mo, Tc, Ru, Rh, Pa, and I were detected in the Co acetylacetonate lattice. The capture of ^{103}Ru by the five different acetylacetonates was measured, and the results obtained immediately after irradiation and after heating for 5 hrs at 150°C were tabulated. The Rh and Co acetylacetonates had the highest yield and Al acetylacetonate had the lowest. It was hypothesized that the formation of the fission product labeled acetonate does not arise from a direct hot atom reaction but from ion exchange in the solid. (J.S.R.)

287 GRAFTING OF ACRYLONITRILE TO DIFFERENT CELLULOSIC MATERIALS BY HIGH-ENERGY RADIATION. Hebeish, A.; Mehta, P. C. (Ahmedabad Textile Industry's Research Association, India). Text. Res. J., 38: 1070-1(Oct. 1968).

Grafting of acrylonitrile (AN) to three cellulosic substrates (viscose, mercerized cotton, and native cotton) was studied, using mutual irradiation as well as pre-irradiation techniques. Irradiation was carried out in a ^{60}Co gamma-cell source with a dose rate of 5×10^5 R/hr. The results showed that with both methods, the rate of grafting was highest for viscose and least for native cotton. With all three substrates and with both irradiation techniques, percent grafting reached a maximum and steady value in 1.5 to 2 hr. This maximum value was higher for mercerized cotton than for viscose. Graft yields were significantly higher with the mutual irradiation technique. (P.C.H.)

288 HIGH-YIELD PRE-IRRADIATION GRAFTING TO WOOL LEADING TO HIGHLY ELASTIC FIBERS. Williams, J. L.; Stannett, V. (Camille Dreyfus Lab., Research Triangle Park, N. C.). Text. Res. J., 38: 1065-6(Oct. 1968).

A high-yield pre-irradiation method is described for grafting wool to ethyl acrylate and polyethyl acrylate. Grafting was carried out in the presence of a mutual solvent for the monomer and water (swelling agent). Results using both acetone and dioxane as the solvent are described. The reason for the different pre-irradiation grafting behavior in the presence of a mutual solvent is believed to be due to the lower activity of the water in the presence of the solvent. Closer examination of the high-yield pre-irradiation grafting curve indicated that there is virtually a sharp break in the grafting curve, where the initial rate suddenly changed to a second, considerably faster rate. There was also a correspondingly abrupt change in the elastic properties of the samples taken from the two regions of the curve. (P.C.H.)

289 RADIATION-INDUCED H–T SUBSTITUTION IN THE SYSTEM AROMATIC HYDROCARBON–METHANOL. DEPENDENCE OF SUBSTITUTION ON CONCENTRATION. Kroh, J.; Plonka, A. M. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 387-90(1968).

Studies were made on the nature of the active species responsible for tritium substitution in the γ radiolysis of benzene and toluene solutions of tritiated methanol. It was found that, within the concentration range up to 50 mmoles of methanol in benzene or toluene, the yields of substitution are likely to attain a relatively constant value. Further increase in methanol concentration, up to about 150 mmoles, confirmed this supposition. The increase of methanol concentration above about 150 mmoles caused a significant increase in the yield of substitution. This is probably due to the change of the radiolytic mechanism of benzene caused by the presence of relatively large amounts of methanol, i.e., to the contribution of the radiolytic intermediates of methanol to the substitution. A preliminary analysis of the scavenging action of methanol in radiation chemistry of aromatic hydrocarbons is presented. (P.C.H.)

290 MECHANISM OF THE FORMATION OF ACETALDEHYDE AND BUTANEDIOL IN THE RADIOLYSIS OF ETHANOL. Basson, R. A. (Atomic Energy Board, Pretoria). J. Chem. Soc., A, No. 8, 1989-92(1968).

The yields of the major products of the radiolysis of pure ethanol at low doses (4×10^{17} eV/ml) are: G(H_2) 5.0, G(MeCHO) 3.2, and G($MeCHOH)_2$ 1.7. The glycol yield is independent of dose up to 10^{20} eV/ml but G values of the other products decrease with increasing dose by about one unit each to well defined plateaux. Above 10^{20} eV/ml all values show a further decrease. The variation in previously reported yields is partially explained by this dose effect. Studies of the effects of ferric chloride, oxygen, and carbon dioxide indicate that dimerization of hydroxyethyl radicals is the only source of this product and that disproportionation of these radicals accounts for about half the acetaldehyde yield. The rate constants for dimerization and disproportionation are approximately equal. The unscavengeable yields of hydrogen and acetaldehyde are equivalent, and studies of the effect of carbon monoxide suggest that these are obtained by two different processes. The data from this system also indicate that the ethanol parent ion reacts with the substrate both by proton transfer and by hydrogen abstraction. (auth) (UK)

291 RADIATION-INDUCED H–T SUBSTITUTION IN THE SYSTEM AROMATIC HYDROCARBON–METHANOL. EFFECTS OF OXYGEN AND NAPHTHALENE. Kroh, J.; Plonka, A. M. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Chim., 16: 383-6(1968).

Benzene and toluene solutions of tritiated methanol were γ irradiated at a dose rate of 3×10^{18} eV/l/sec. The results showed that the degree of substitution, which is defined as the ratio of the final specific activity of the benzene or toluene to the initial specific activity of the respective solution prepared for irradiation, was greater in the aerated than in the deaerated solution. It was also noted that the rapid increase of the degree of substitution (otherwise called total) with the dose of γ-rays in aerated, undistilled hydrocarbons became linear in the deaerated hydrocarbons. The addition of naphthalene diminished the degree of substitution only in the undistilled samples. However, the effects of naphthalene in the benzene solution of methanol were greater than that in the toluene solution. (P.C.H.)

292 RADIOLYSIS OF BINARY MIXTURES. PART III. ISOTOPE EFFECTS IN METHANOLIC SOLUTIONS OF DEUTERIATED NAPHTHALENE. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Kensington). J. Chem. Soc., A, No. 10, 2412-15(1968).

The effects of perdeuteriobenzene and deuteriated naphthalene on the yields of D_2, HD, and CH_3D from methanolic solutions were examined. The results indicate that hydrogen-atom abstractions contribute significantly to the yield of hydrogen from methanol. This hydrogen yield was unaffected by the addition of scavengers. The isotope effects associated with the formation of the scavenging products anisole, cyclohexadienemethanol, cyclohexa-1,4-diene, phenylcyclohexadiene and biphenyl formed in methanol–benzene solutions were also examined. The isotope effect is defined as the ratio of product G-values in $CH_3OH + C_6H_6$ to those in $CH_3OH + C_6D_6$. Positive isotope effects were observed in the formation of biphenyl and anisole, while cyclohexadienemethanol displayed a reverse isotope effect, i.e., smaller than unity. Cyclohexa-1,4-diene and phenylcyclohexadiene showed complex isotope effects, which were positive in pure benzene but reverse in benzene–methanol solutions. The decomposition of naphthalene is also associated with a reverse isotope effect. The isotope effects were used to elucidate fundamental processes occurring in the radiolysis of binary mixtures containing methanol. (auth) (UK)

293 RADICAL PROCESSES IN RADIOLYSIS OF THE ETHANOL–BENZENE SYSTEM. Kroh, J.; Mayer, J. (Technical Univ., Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 377-82(1968).

The γ radiolysis of ethanol–benzene at 20 and −196°C was studied with special reference to the reactions of CH_3CHOH and C_6H_7 radicals. The radiation yields of 2,3-butanediol produced in the radiolysis of solid ethanol was about one-fourth that observed in the liquid phase. The yields depended markedly on the presence of impurities, which led to large differences in G-values. The results also showed that the decay of C_6H_7 radicals at higher temperatures (110°K) was slower than the disappearance of CH_3CHOH. Mechanisms for the reactions are discussed. (P.C.H.)

294 METHOD FOR PRODUCING A PECULIAR COPOLYMER. Fukui, Kenichi (to Sumitomo Chemical Co., Ltd.). Japanese Patent 1968-9072. Apr. 12, 1968. Filed July 10, 1964.

Irradiation of a mixture of a cyclic polymer of formaldehyde and ethyleneurea with ionizing radiation yields a copolymer. (NSA of Japan)

295 COMPARISON OF PHOTO- AND γ-INDUCED IONIZATION PROCESSES IN THE CONDENSED PHASE BY MEANS OF ELECTRON SPIN RESONANCE SPECTROSCOPY. Tsuji, Kozo; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Phys. Chem., 72: 3884-93(Oct. 1968). (ORO-2968-36).

The production of electrons by photoionization and γ irradiation was studied in several rigid organic glasses by the ESR technique. A steady-state concentration of electrons is achieved rapidly during photoionization but not by γ irradiation. In the latter case the concentration increases linearly with dose to a maximum value and then declines. After irradiation, the trapped electrons undergo thermal decay at rates which are highly characteristic of the matrix system and the experimental conditions but are almost independent of the method of electron generation. During photo-

ionization, ESR evidence for a transient triplet state of N,N,N',N'-tetramethyl-p-phenylenediamine (TMPD) was obtained in several solvents at 77°K. After warming up samples which were photoionized at 77°K, well-resolved ESR spectra of $TMPD^{\cdot+}$ were obtained in alcohol systems. Two slightly different spectra were observed depending on the experimental conditions, and these were assigned to $TMPD^{\cdot+}$ and its dimer although the identification of the latter is inconclusive. When the light beam is cut off in TMPD photoionization, there is a sudden decrease in the electron concentration which is not related to the thermal decay of trapped electrons. A mechanism of photoionization was proposed that includes the participation of a delocalized state as a precursor to ionization and of excited electrons. Photobleaching of trapped electrons was studied in several solvent systems and evidence has been obtained for the reactions of excited electrons with alcohol. (auth)

296 CHEMICAL EFFECTS OF NEUTRON-INDUCED NUCLEAR REACTIONS IN HALATES AND RELATED COMPOUNDS. II. (n,2n) REACTION IN BROMATES. Ambe, Fumitoshi; Sano, Hirotoshi; Saito, Nobufusa (Tokyo Univ. Inst. of Physical and Chemical Research, Tokyo). Radiochim. Acta, 9: 116-18(Aug. 1968).

The recoil effects of the (n,2n) reaction were studied in bromates. In sodium bromate the distribution of radioactive bromine atoms in various chemical forms was almost the same for the $^{79}Br(n,2n)^{78}Br$ and $^{79}Br(n,\gamma)^{80}Br$ reactions. A similar relationship between the retention and the nature of cations was found for the (n,2n) and (n,γ) reactions in several bromates. (auth)

297 RECOIL TRITIUM REACTIONS IN SIMPLE ALIPHATIC COMPOUNDS. EXCITATION-DECOMPOSITION IN HYDROGEN SUBSTITUTION. Cipollini, R.; Stoecklin, G. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). Radiochim. Acta, 9: 105-12(Aug. 1968).

Some reactions of recoil tritium produced via the $^3He(n,p)$ T- and the $^6Li(n,\alpha)$ T-process, respectively, were studied in gaseous and liquid aliphatic compounds of the type RX (X = NH_2, OH, SH, halogen). Except for a remarkably high HT-yield in gaseous and liquid labile H-containing systems the product forming mechanisms seem to follow the general pattern of the chemistry of energetic tritium atoms. Liquid phase competition experiments in equimolar $CH_3NH_2/C_2H_5NH_2(I_2)$- and $CH_3NH_2/n\text{-}C_3H_7NH_2(I_2)$-systems show a stronger structure effect on hydrogen replacement than expected on the basis of the "impact model". The ratios of the relative yields per C−H bond are 1.00 : 0.67 : 0.50 for methyl-, ethyl- and n-propylamine, respectively. The effect of bond energies on excitation-decomposition following hot hydrogen substitution was studied using scavenged gaseous, equimolar CH_3X/C_3H_8-systems. The CH_2TX-yields are shown to decrease in the order $CH_2TF > CH_2TOH > CH_2TCl > CH_2TNH_2 > CH_2TSH$ thus indicating that the energy of the weakest bond in the molecule plays a major yield-determining role. Pressure- and phase-effects confirm that a considerable fraction of the hot substitution product can decompose at 1 atmosphere before collisional de-excitation occurs. Primary steric and chemical factors seem to be small compared to the secondary decomposition effects, particularly for compounds with weaker bonds. (auth)

298 REACTIONS OF NUCLEOGENIC CHLORINE ATOMS WITH SIMPLE AROMATIC COMPOUNDS. II. RECOIL CHLORINATION. Stoecklin, G.; Tornau, W. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). Radiochim. Acta, 9: 95-105 (Aug. 1968).

Reactions of recoil chlorine resulting from the $^{37}Cl(n,\gamma)^{38}Cl$-process were studied in liquid aromatic compounds of the type C_6H_5X [X = F, Cl, I, CH_3, NO_2], using both binary CCl_4/C_6H_5X-systems and 2 mole % Cl_2-containing pure aromatic substrates. No pronounced orientation effects for the o-, m-, p-distribution of the monochloro isomers are observed at high ArH concentration. The functional group has little or no influence on the reactivity of the aromatic compound towards hydrogen substitution. The lack of selectivity and reactivity effects indicates the absence of electrophilic substitution processes. It is suggested that recoil chlorination largely proceeds via hot, neutral chlorine atoms. Comparison with results obtained from the γ-radiolysis of the corresponding systems show that deviations from purely non-discriminating reactions can be ascribed to caged thermal radical reactions. The yield for heavy atom and group displacement at high ArX concentration increases in the following sequence of the displaced group X : $CH_3 < CF_3 < F < I < NO_2 < Cl$. The mass of the displaced atom or group and cross sectional effects, rather than bond energies are shown to be yield-determining factors the lack of bond energy effects and the almost complete retention of the original isomeric form after chlorine replacement in o- and m-dichlorobenzene rules out an addition-type reaction followed by a decomposition of the excited intermediate. Both hot replacement reactions and caged thermal radical reactions are assumed to be responsible for the formation of $C_6H_5{}^{38}Cl$ from C_6H_5X. (auth)

299 PULSE-RADIOLYSIS SYSTEM FOR THE OBSERVATION OF SHORT-LIVED TRANSIENTS. Bronskill, M. J.; Hunt, J. W. (Univ. of Toronto). J. Phys. Chem., 72: 3762-6(Oct. 1968).

Several interesting problems in the field of radiation chemistry occur in the time interval from 0.01 to 1 nsec following the passage of an ionizing particle. Existing pulse-radiolysis systems are unable to investigate these problems because their time resolution is limited to about 1 nsec. A new technique is described which is theoretically capable of observing transient absorption signals as short-lived as 0.02 nsec. This technique will use the Cherenkov light produced by the 30-MeV electron beam from the Toronto linear accelerator to detect the absorption of transient species produced by the fine-structure pulses (0.01 nsec wide) of the electron beam. A stroboscopic effect is created by varying the phase difference between the Cherenkov light flashes and the fine-structure electron pulses. With this technique a conventional slow detection system can be used to achieve a time resolution of 0.02 nsec. Experimental observations indicate that such a detection system is completely practical, although no short-lived transients have yet been observed. (auth)

300 POSITIVE CHARGE MIGRATION IN γ-IRRADIATED ORGANIC SOLIDS AND TRAPPING BY ALKANES AT 77°K. Louwrier, Pieter W. F.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 72: 3878-83(Oct. 1968).

Alkanes (RH) of seven or more carbon atoms in matrices of CCl_4 or 3-methylpentane (3MP) at 77°K are strongly colored by ^{60}Co irradiation. The absorption bands are structureless, the half-width is ~400 nm, and λ_{max} increases from 560 nm for C_7H_{16} to ~910 nm at $C_{15}H_{32}$ and higher. They are attributed to the alkane radical ions, RH^+. One-component alkane systems, with CCl_4 or CO_2 as electron traps, are not colored, and higher alkanes do not trap holes in 3-methylhexane and higher alkane matrices, possibly because the difference of ionization potentials (trap depth) becomes too small above hexane. For 2-methyldecane (2MD) in 3MP, the yield of $2MD^+$ increases to a sharp maximum at 0.5 mol % 2MD and diminishes to half below 2% 2MD when observed shortly after irradiation. Upon standing, $OD(2MD^+)$ decreases, the rate being faster at higher % 2MD. Both effects are attributed to positive charge migration by electron tunneling from RH to RH^+. Optical excitation of RH^+ transfers holes to CCl_4 or tetramethyl-p-phenylenediamine, and bleaching is more efficient on the blue side of the RH^+ band, indicating excited hole migration. (auth)

301 SUBSTITUENT EFFECTS IN CYCLOHEXADIENYL RADICALS AS STUDIED BY PULSE RADIOLYSIS. Cercek, B. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). J. Phys. Chem., 72: 3832-6(Oct. 1968).

The effect of electron-donating and electron-withdrawing substituents on the second-order decay of hydroxycyclohexadienyl radicals, $\cdot HOC_6H_5X$, and their reactivity toward oxygen was studied using the technique of pulse radiolysis. The reactions of $\cdot HOC_6H_5X$ radicals are enhanced by electron-donating substituents and retarded by substituents that are electron-withdrawing. The activation energies for the second-order decay of $\cdot HOC_6H_5X$ radicals increase with increasing dipolar character of the species. (auth)

302 ELECTRON SPIN RESONANCE STUDIES OF RADIOLYTICALLY PRODUCED RADICALS IN AQUEOUS NITROALKANE SOLUTIONS. Eiben, K.; Fessenden, Richard W. (Mellon Inst., Pittsburgh). J. Phys. Chem., 72: 3387-93(Oct. 1968).

ESR spectroscopy was used to examine basic aqueous solutions of nitroalkanes during radiolysis with high-energy electrons. Irradiation was carried out directly in the ESR cavity; the sample container was a flat cell of high-purity silica. Although an intense ESR line arose from the cell, this line was narrow and blanked out only a relatively small portion of the spectrum. The radicals detected in basic solutions (pH 10−12) of 5×10^{-3} M nitromethane were $CH_2NO_2^-$ and $HOCH_2NO_2^-$. Use of the additives N_2O and methanol led to the conclusions that the $CH_2NO_2^-$ is formed by a reaction of the hydrated electron, that OH adds to the basic form of nitromethane ($CH_2{=}NO_2^-$) to give $HOCH_2NO_2^-$, and that the alcohol radical formed by the OH attack on methanol also adds to this basic form but in competition with an electron exchange leading to $CH_2NO_2^-$. The radical with the shortest lifetime, $HOCH_2NO_2^-$, was found to have a half-life of about 1 msec. Several other nitroalkanes were studied with similar results. (auth)

303 REACTIONS OF HYDROGEN ATOMS IN AQUEOUS SOLUTIONS. SOME AMINO ACIDS. Volkert, Wynn A.; Kuntz, Robert R. (Univ. of Missouri, Columbia). J. Phys. Chem., 72: 3394-3400(Oct. 1968).

The ^{60}Co γ radiolysis of acidic aqueous solutions of amino acids and related compounds was carried out in order to determine relative rates of H atom reactions with these compounds. These rates were measured by competition of H atom donor and scavenger species for the radiolytic H atoms. Rate constant ratios were evaluated by a graphical technique utilizing the variation of $G(H_2)$ with solute concentration. The H atom donor species were in competition with allyl alcohol for radiolytic H atoms while the aromatic and sulfur-containing acids which serve as H atom scavengers were allowed to compete with formic acid. Absolute rate constants were derived using known rates for various competitors. Rate constants derived were in the range of 10^5 to 10^6 l/mol sec for abstractions and ca. 10^9 l/mol sec for additions. The amino acids were selected so the effect of substituents on the side chain could be studied. Decompositions were kept below 0.1% to avoid scavenging of H atoms by reaction products which result from the H atom and OH radical attack on the species. Electrons were scavenged by H_3O^+ and did not contribute significantly to the overall decomposition. (auth)

304 TRAPPED ELECTRONS IN γ-IRRADIATED POLYETHYLENE IDENTIFIED BY ELECTRON SPIN RESONANCE SPECTROSCOPY. Keyser, Ronald M. (Oak Ridge National Lab., Tenn.); Tsuji, Kozo; Williams, Ffrancon. Macromolecules, 1: 289-90(May–June 1968).

The ESR spectra of trapped electrons in γ-irradiated polyethylene were studied using two types of polyethylene. The first was an antioxidant-free low-density sample (Alathon 1414), and the other was a commercial sample of Marlex 50. The samples were fabricated from pellets or powder into uniform cylindrical rods 3 or 5 mm in diameter. Preliminary results showed that the radiation yield of trapped electrons in Marlex 50, $G(e^-)$ 0.5, was greater than in Alathon 1414. Both in the Alathon and Marlex specimens, a slow thermal decay of the ESR singlet was detectable at −196° after irradiation and amounted to as much as a 20% decrease in the amplitude of the signal measured over a period of 1 hr. At higher temperatures, the decay was more rapid. (P.C.H.)

305 FREE RADICAL CONCENTRATION IN IRRADIATED STARCH AS A FUNCTION OF IRRADIATION DOSE. Adamic, K. (Inst. Ruder Boskovic, Zagreb); Cevc, P; Korotchenko, K. A. Staerke, 19: 336-7(1967).

By the ESR study of the concentration of the most stable radicals as a function of irradiation dose it has been found that the saturation concentration in γ irradiated starch appears at about 50 Mrad. This resuut is in agreement with the previously established stagnation in changes of the physicochemical properties of starch with increasing irradiation dose. (auth)

306 THE EFFECT OF TEMPERATURE ON RADIATION-INDUCED DEGRADATION OF POLY(METHYL METHACRYLATE). Kroh, J.; Polowinska, A. (Technical Univ., Lodz, Poland. Inst. of Polymers, Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 425-8(1968).

The effects of temperature on the γ radioinduced degradation of solid poly(methyl methacrylate) (PMM) in the presence and absence of air was investigated. Arrhenius plots demonstrating the temperature dependence of degradation of deaerated and aerated PPM are illustrated. The value $(1/M - 1/M_0)$, where M and M_0 denote the molecular weights of PMM after and before degradation, was proportional to the yield of degradation. With all the polymer samples a rapid change in degradation yield occurred at about −20°C both in the absence and presence of air. It was concluded that the temperature effect observed might be ascribed to the changed conditions of radical deactivation. (P.C.H.)

307 EFFECT OF TEMPERATURE ON RADIATION-INDUCED DEGRADATION OF POLY(METHYL METHACRYLATE) IN SOLUTION. Kroh, J.; Polowinska, A. (Technical Univ., Lodz, Poland. Inst. of Polymers, Lodz, Poland). Bull. Acad. Pol. Sci., Ser. Sci. Chim., 16: 429-31(1968).

The effects of temperature on the γ-radioinduced degradation of frozen poly(methyl methacrylate) in benzene and acetone solutions were investigated. It was found that the degradation of polymer in solution underwent a rapid change at a certain definite transition temperature. This temperature was −98 and −25°C for acetone and benzene solutions, respectively. In the benzene solution the transition temperature (−25°C) was lower by about 30°C than the melting point of the system. Thus the change in the degradation mechanism did not necessarily coincide with the phase transition. Reasons for these differences are discussed. (P.C.H.)

308 RADIOLYSIS OF WATER VAPOR BY α- AND X-IRRADIATION. Hofmann, S. Technische Hochschule, Munich). Radiochim. Acta, 9: 118-25(Aug. 1968). (In German).

The radiolysis of pure saturated water vapor by α irradiation (ca. 5-MeV) has been studied at 58°C (corresponding to vapor pressure of 140 torr) for two different dose rates, 5.42×10^{15} eV/s and 1.84×10^{15} eV/s, respectively. A constant G-value of $G(H_2) = 1.28 \pm 0.15$ for the hydrogen production was observed in both series of experiments. It turns out that $G(H_2)$ is temperature-independent between 40°C (≙60 mm Hg) and 80°C (≙360 mm Hg). For the irradiation of pure saturated D_2O-vapor at 60°C (≙150 mm Hg) a G-value of $G(D_2) = 1.2 + 0.2$ was observed. Irradiations in the presence of oxygen at 64.7°C (≙190 mm Hg) have shown a linear decrease of $G(H_2)$ with increasing oxygen concentration x (mole-%): $G(H_2) = 1.28 - 0.67 \cdot x$ ($x \leq 1.5$ mole-% of O_2). Addition of methane at 64.7°C gave rise to a marked increase of $G(H_2)$ from 1.28 to 4.4 for $x \leq 0.1$ mole-% of CH_4. This value remains constant after further addition of methane up to 1.2 mole-%. The same experimental device was used for x irradiations (90-kV) with an average dose rate of 8.4×10^{13} eV/s. The $G(H_2)$-value was found to be ≤0.2. (auth)

309 STRENGTH OF IRRADIATED POLYMETHYL METHACRYLATE. Mikitishin, S. I.; Tynnyi, A. N.; Bazilevich, Z. A. (Lvov Physico-Mechanical Inst.). Fiz.-Khim. Mekh. Mater., 4: 459-62(1968). (In Russian).

The influence of various types of radiation (reactor, γ, x, and uv) and absorbed energy on the strength of poly(methyl methacrylate) was studied. It was shown that the strength of the polymer depends primarily on the extent of defects induced and not on their distribution in depth. Therefore, during uneven radiation energy distribution across the specimen, the radiation resistance is determined by the amount of dose absorbed by the surface layer. (tr-auth)

310 ELECTRONS, IONS, AND EXCITED STATES IN THE PULSE RADIOLYSIS OF DIOXANE. Baxendale, J. H.; Rodgers, M. A. J. (Univ., Manchester, Eng.). J. Phys. Chem., 72: 3849-55(Oct. 1968).

Changes in the absorption attributable to the solvated electron in dioxane toward shorter wavelengths are produced by addition of water and lithium aluminum hydride. With water the change occurs gradually as the water content increases, as might be expected from a change in solvation environment. With lithium aluminum hydride the lifetime of the electron is increased appreciably due to the replacement of reactive cations by the inert Li^+, which probably also accounts for the wavelength shift. Anthracene anions, formed with G = 0.12 in pure dioxane are also stabilized and their yield increased by the hydride. The mechanism of anthracene triplet formation was studied by observing the effect of additives on the triplet yield. Water and lithium aluminum hydride have little effect, and it was concluded from this that ions of solute or solvent are not precursors. Kinetic observations and the effects of benzene and acetone are consistent with the assumption that excited states of the solvent are involved in its formation. (auth)

311 PULSED RADIOLYSIS OF LIQUID CYCLOHEXANE AND n-HEXANE. I. YIELD OF HYDROGEN ATOMS MEASURED BY THE CYCLOHEXADIENYL RADICAL ABSORPTION IN SOLUTIONS CONTAINING BENZENE. II. ABSORPTION SPECTRA AND REACTIONS OF CYCLOHEXYL AND HEXYL RADICALS. Sauer, Myran C. Jr.; Mani, Inder (Argonne National Lab., Ill.). J. Phys. Chem., 72: 3856-62(Oct. 1968).

The pulsed radiolysis of solutions of benzene in cyclohexane and n-hexane yields the cyclohexadienyl radical, ($C_6H_7\cdot$), absorbing at 315 mμ. Studies of the intensity of this absorption as a function of benzene concentration indicates that thermal hydrogen atoms react by (1) $H\cdot + RH \rightarrow H_2 + R\cdot$ and (2) $H\cdot + C_6H_6 \rightarrow C_6H_7\cdot$, with $k_2/k_1 = 35 \pm 15$ for cyclohexane and 37 ± 10 for n-hexane. The G values for thermal hydrogen atoms are 1.3 ± 0.4 in cyclohexane and 1.8 ± 0.4 in n-hexane. In the pure solvents, absorbing radicals were produced with maxima at 240 mμ in cyclohexane (cyclohexyl, $^{240}\epsilon = 2.1 \pm 0.4 \times 10^3$ M^{-1} cm^{-1}) and at 235 mμ in n-hexane (hexyl, $^{235}\epsilon = 1.4 \pm 0.3 \times 10^3$ M^{-1} cm^{-1}). The maxima were unchanged when the radicals were produced in aqueous solution, but the values of $^{240}\epsilon$ were lower ($1.48 \pm 0.15 \times 10^3$ M^{-1} cm^{-1} and $0.96 \pm 0.10 \times 10^3$ M^{-1} cm^{-1} for cyclohexyl and hexyl, respectively). The rate constants for radical + radical reaction are, in units of 10^9 M^{-1} sec^{-1}, for cyclohexyl 2.0 ± 0.6 and 1.4 ± 0.2 in cyclohexane and water, respectively, and for hexyl 3.1 ± 0.9 and 1.2 ± 0.2 n-hexane and water, respectively. (auth)

312 THE EFFECT OF PRE-HEATING ON THERMAL ANNEALING IN NEUTRON IRRADIATED TRIS-ACETYLACETONE Co(III). Shankar, J.; Nath, Amar; Thomas, V. G. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem., 30: 1361-71(July 1968).

The kinetics of isothermal annealing of recoil in pre-heated and untreated (normal) samples of tris-acetylacetone Co(III) were

compared. In pre-heated samples the extent of thermal annealing was found to decrease exponentially with time of pre-heating. The "variable depth electron donor" model for thermal annealing postulates the formation of three types of electron donors, and an attempt was made to determine their contributions towards annealing. It was found that about one-third of the annealing is unaffected by the presence of oxygen and the density of defects, and so can be attributed to the electron donors formed toward the end of the recoil track. The rest of the annealing is controlled by the density of the pre-existing crystal defects, since they could be annealed by a prior heat treatment. (auth) (UK)

313 RADIATION TREATMENT TO RENDER POLYESTERS SUSCEPTIBLE TO PERMANENT RETENTION OF DYES. (to Atomic Energy of Canada Ltd.). British Patent 1,129,424. Oct. 2, 1968. Priority date Feb. 23, 1967, Canada.

The dyeability of polyethylene terephthalate or polycyclohexyl terephthalate is improved by γ-induced grafting of a vinyl monomer or a vinylidene monomer containing a hydrophilic end group onto the polyester. The irradiation is carried out in a solution of methanol, ethanol, or a mixture of these two, and the polyester may be irradiated in the form of filaments, fibers, staples, films, or fabrics. The irradiation temperature may vary from 20 to 60°C. (B.L.M.)

314 ELECTRONIC PARAMAGNETIC RESONANCE IN IRRADIATED POLYMERS ON THE BASE OF CARBAZOLE. Budnikova, E. S.; Mikhailova, T. G.; Sirotkina, E. E.; Lopatinskii, V. P. (Inst. of Physics and Tech., Novosibirsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 128-30(1968). (In Russian).

EPR spectra of 9 methylcarbazole, 9 ethylcarbazole, 9 isopropylcarbazole, and the corresponding 3-vinyl monomers (3V9MC, 3V9EC, and 3V9IPC) irradiated by 10^6 R of ^{60}Co γ-rays at room temperature were studied in order to determine the mechanism of radioinduced crosslinking and formation of polymer radicals. (R.V.J.)

315 IMPURITIES IN ^{64}Cu PRODUCED BY (n, γ) REACTION. Nakamura, Haruto; Yamabayashi, Hisamichi. Nippon Genshiryoku Gakkaishi, 10: 550-3(1968). (In Japanese).

In order to produce high purity radioisotopes by (n, γ) reactions it is important to use highly pure target materials. It is not advisable to attempt elimination of the impurities after irradiation when producing isotopes of short half-life, because the specific activities would be decreasing during the time required for the process. The purities of standard reagent grade copper from two production forms were compared by activation analysis without any radiochemical separation. The purer of the two was selected, and the impurities in it were determined accurately by activation analysis with radiochemical separation. Among the impurities found in the product nuclide, ^{65}Ni and ^{60}Co can derive from fast neutron reaction on the target material as well as from impurities originally contained in the target. It was confirmed by determination of nickel by polarographic method that the greater part of the ^{65}Ni activity detected was due to ^{65}Cu(n, p) ^{65}Ni reaction. It was found that the purity of the target was high enough to produce 99.99% radiochemically pure ^{64}Cu isotope. (auth)

316 STUDIES IN RADIATION POLYMERIZATION. XI. THE RADIATION POLYMERIZATION OF N-PARA- AND N-META-CHLOROPHENYLMALEIMIDES. Ivanov, V. S.; Smirnova, V. K.; Fomina, A. M.; Sidorova, T. I.; Zheleznikov, F. G.; Khomyakov, A. M.; Andreev, A. S. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 10, 137-40(May 1968). (In Russian).

The radiation polymerization of N-para- (γ rays from ^{60}Co) and N-meta- (fast electrons) chlorophenylmaleimides was carried out. The polymers prepared were characterized by solubility, softening and decomposition temperatures, and ir spectra. (auth)

317 TEMPERATURE DEPENDENCE OF RADIATION INDUCED TRANS → CIS ISOMERIZATION OF STILBENE IN TOLUENE. Fischer, E. (Weizmann Inst. of Science, Rehovoth, Israel); Fischer, G.; Stein, G. Chem. Phys. Lett., 2: 405-6(Oct. 1968).

The rate of γ-radioinduced trans → cis isomerization of stilbene in dilute toluene solutions from −95° to +100° showed a maximum at about +25°. The results are interpreted in terms of interplay of opposing reactions and of the role of triplet toluene. (auth)

318 ESR STUDIES OF ELECTRONS TRAPPED IN THE DIPOLE FIELDS OF POLAR MOLECULES IN THE CRYSTALLINE STATE. Bonin, M. A.; Takeda, K.; Tsuji, K.; Williams, F. (Univ. of Tennessee, Knoxville). Chem. Phys. Lett., 2: 363-5(Oct. 1968).

It has been previously reported that electrons are bound to polar molecules containing the cyanide group after γ-irradiation of these compounds in the crystalline state at 77°K. Subsequent photobleaching of these radioinduced color centers results in either dissociative or nondissociative electron capture by the molecules. Two cases are reported where the products of this photochemical reaction undergo thermal reversion to the trapped electron. ESR studies show that the trapped electron is incorporated in the crystal lattice. These results appear to support previous theoretical propositions relating to the binding of an electron in a dipole field. (auth)

319 TECHNICAL-ECONOMIC ASPECTS OF RADIATION METHOD FOR SULFONATE PRODUCTION. Osipov, V. B.; Guteev, V. P.; Dzhagatspanyan, R. V.; Gershenovich, A. I.; Golubkov, S. V. At. Energ. (USSR), 25: 320-1(Oct. 1968). (In Russian).

Economic and technological evaluation of the radiation method of sulfonate production using sulfochlorator RS-2.5 showed an hourly production of 360 kg of sulfonate with a maximum production reaching 500 kg/hr (considering losses on sulfochloride saponification), which is about 1.5 to 2 times higher than production by ordinary photochemical methods. Continuous operations of the RS-2.5 sulfochlorator during 300 days produced 2400 to 3600 tons of sulfonate. The cost of the sulfochlorator construction was 80,000 rubles with the source cost of 15,000 rubles. Specifications of construction and operational costs are tabulated. (R.V.J.)

320 RECOIL THERMAL ANNEALING IN BROMATES. II. THE ISOTOPE EFFECT. Campbell, I. G. (Univ. of Manchester, Eng.); Jones, C. H. W. Radiochim. Acta, 9: 71-6(Aug. 1968).

The temperature dependence of the isotope effect in the thermal annealing of ^{80m}Br and ^{82}Br(n,γ) activated recoils in barium and lithium bromate was examined. In barium bromate an isotope effect of 6% was observed and this derives from a discrete annealing reaction below 125°C which occurs only for ^{82}Br recoils. Above this temperature both types of recoil anneal through defects present as an inherent property of the lattice. In lithium bromate the absence of an isotope effect illustrates the remarkable similarity of the two types of recoil site which apparently derives from excitation and ionisation of the lattice produced by neutron-induced fission fragments of ^{6}Li. This phenomenon may be dose-rate dependent. The enhanced recoil annealability in this compound is due to a component in the annealing distribution above 175°C. (auth)

321 AN ELECTRON PARAMAGNETIC RESONANCE INVESTIGATION OF SOME GROUND STATE TRIPLET MOLECULES. Kempf, Richard Joseph. University Park, Pa., Pennsylvania State Univ., 1967. 198p.

Thesis.

Zero-field splitting parameters D and E, and the g-factors were examined for a series of odd alternant methylenes consisting of propargylene and some of its homologs in randomly oriented samples. By observing the EPR spectra of these triplet compounds at two different frequencies it is possible to evaluate D and E as well as the g-factors of the molecules. The observation of the EPR spectrum of triplet CH_2 was also attempted, since if the spin–orbit interaction is involved at all in the zero-field splitting of the ground state methylenes, it would possibly make a large contribution in the methylene fragment where various one-center integrals contribute to the spin–orbit interaction energy. From the X-band and P-band EPR spectra taken at low temperature, the g-factors were evaluated for the triplet alternant methylenes. They were found to be close to the free electron value, thus validating the often used assumption of setting g equal to the free electron value in the evaluation of D and E from polycrystalline samples. The accuracy, however, is not as good as that obtained from a single crystal experiment because the EPR spectral lines are usually very broad. Measurement of the zero-field splitting parameters leads to a partial description of the spin density distribution in the triplet molecule and also to determination of the geometry of the molecule in certain cases. In order to account for the magnitude of D, both positive and negative spin densities must be present. Also the value of D for the alternant methylenes can be related to the value of the zero-field splitting in methylene itself. The effect of the matrix on the linewidths of the $\Delta m = 1$ resonances as well as the substituent effects on the zero-field splitting in dephenyl-methylene was also studied. The linewidth was found to be sensitive to the environment; the narrowest lines being observed in matrices whose structure closely approximated the structure of the triplet molecule. Substituents improved the delocalization of the triplet electrons away from the central carbon atom and this led to lower D values as expected. Gamma irradiation of sodium acetate in an alkali halide matrix was studied in an attempt to produce CH_3, and it led to the observation of the EPR spectrum of the CO_2^- and CO_3^- radical anions. The temperature dependence of the width of the CO_3^- spectrum was investigated and a barrier to reorientation of CO_3^- in KBr and KCl matrices was measured.

A mechanism was also proposed for the production of CO_3^- from acetate. (Diss. Abstr.)

322 I. REACTION OF DILUTE AQUEOUS CH_3I WITH IODINE ACTIVATED BY NUCLEAR PROCESSES. II. REACTION OF GASEOUS CH_4 WITH IODINE ACTIVATED BY NUCLEAR PROCESSES. III. PROMPT LUMINESCENCE DURING GAMMA- AND X RAY IRRADIATION OF 3MP GLASS AT 77°K. Wilkey, D. Dennis. Madison, Wis., Univ. of Wisconsin, 1968. 130p.
Thesis.

The isomer ^{130m}I was used to investigate the Szilard-Chalmers chemistry of iodine. The chemical reactions initiated by the isomeric transition were compared with those initiated by the $^{127}I(n,\gamma)^{128}I$ and $^{129}I(n,\gamma)^{130}I$ processes. Such studies were made in both gaseous methane and aqueous methyl iodide systems. About 10% of the ^{128}I formed by the $^{127}I(n,\gamma)^{128}I$ reaction is found in organic combination following neutron irradiation of aqueous solutions of 0.1 mole % CH_3I and 10^{-3} mole % I_2 or I^-. When aqueous solutions of $CH_3{}^{127}I$ and $I_2(^{129}I)$ or $I^-(^{129}I)$ were irradiated with neutrons, an appreciable organic yield was observed for ^{130}I born from the inorganic scavenger, as well as for ^{128}I from CH_3I. The organic yield of ^{130}I activated by isomeric transition was about 7%. The formation of labeled organic products following activation of iodine atoms by both (n,γ) and isomeric transition in the dilute aqueous solutions of CH_3I is most plausibly explained by the autoradiation hypothesis, which postulates that an atom enters organic combination as a result of radiation effects from its own electrons. The organic yields of the $^{127}I(n,\gamma)^{128}I$ and $^{129}I(n,\gamma)^{130}I$ reactions in gaseous mixtures of CH_4 and I_2 are both 52% within experimental error. The similarity in the yields suggests that all of the (n,γ) produced ^{128}I and ^{130}I are initially charged. Only about 26% of the ^{130}I atoms formed by the $^{130m}I \xrightarrow{IT} {}^{130}I$ process in the gaseous mixtures react to form organic iodides. The lower yield for the isomeric transition compared to that for (n,γ) activation is explained as a consequence of a smaller fraction of the ^{130}I from the $^{130m}I \xrightarrow{IT} {}^{130}I$ process being produced with sufficient kinetic energy to react with CH_4, and/or a lower excitation probability for I^+ ions from the isomeric transition. Experiments were carried out to determine if luminescence occurs as a result of prompt recombination of electrons during the radiolysis of pure 3-methylpentane at 77°K, and to compare the intensity of the prompt luminescence emission with that previously observed due to the recombination of trapped electrons following the irradiation. Low-energy x radiation was employed to avoid interference from Cherenkov radiation. The results show that luminescence is emitted during the irradiation in excess of that which can be ascribed to the thermal decay process observed at 77°K following irradiation. It is estimated that about half of the total luminescence emission occurs as a result of prompt recombination of electrons, assuming that the response of the photomultiplier tube is the same as for luminescence resulting from post-irradiation processes. If all electrons ejected from the 3MP have an equal probability of producing luminescence upon recombination, these results suggest a value of about 1.5 for G(trapped e^-) in 3MP glass. (Diss. Abstr.)

323 NEW CHEMONUCLEAR SYSTEM FISSION FRAGMENTS AND FLUOROCARBONS. Gurley, Richard Norwood. Gainesville, Fla., Univ. of Florida, 1967. 197p.
Thesis.

The radiolysis of CF_4, CF_4-UF_6, $CF_4-UF_6-N_2$, CF_4-UF_6-Ar, CF_4-UF_6-Xe, $CF_4-UF_6-SF_6$, and CF_4-UF_4-C by γ photons and by reactor irradiations was studied. The radiolysis of CF_4-UF_6-Al shavings by reactor irradiations was also studied. The principal product was C_2F_4 with traces of C_3F_6O and C_3F_6O. The parent material, CF_4, was also recovered. For the γ irradiations, expressions were derived that related the fraction of CF_4 remaining after exposure to a known dose. The charcoal used in the γ irradiations of CF_4-UF_6-C acted as a scavenger of F_2. For the reactor irradiations, a mathematical model that related the fraction of CF_4 remaining after exposure to a known dose was obtained. The C, N_2, and Xe in the CF_4-UF_4-C, $CF_4-UF_6-N_2$, and CF_4-UF_6-Xe series acted as scavengers of fluorine. In the nitrogen experiments, NF_3 was produced; in the Xe experiments, XeF_2 and XeF_4 were produced. The addition of Al shavings to capsules that contained CF_4-UF_6 and subsequent reactor irradiations of these capsules resulted in an increased CF_4 destruction rate as compared to the reactor irradiations of capsules that contained only CF_4-UF_6. (Diss. Abstr.)

324 PHOTOCHEMICAL DECOMPOSITION OF METHANETHIOL: HOT HYDROGEN ATOM REACTION WITH DEUTERIUM. Sturm, G. P. Jr.; White, John M. (Univ. of Texas, Austin). J. Phys. Chem., 72: 3679-81(Oct. 1968).

Studies were made on the importance of hot H atoms in the photochemistry of methanethiol. The results of photolysis of CH_3SH with 2537 Å light in the presence of various amounts of D_2 are illustrated. The quantity $2H_2:HD$ was found to be a linear function of the ratio $CH_3SH:D_2$. Addition of a rare gas (He or Ne) increased the $2H_2:HD$ ratio in the products. The mechanism for the reactions is given. The following evidence is presented indicating the importance of hot H atoms in the photochemistry of CH_3SH at 1849 and 2537 Å: positive intercepts were obtained in plots of $2H_2/HD$ vs CH_3SH/D_2; a lower intercept was obtained for 1849 Å light than for 2537 Å light; added rare gas increased the $H_2:HD$ ratio; and thermalization by He was much more effective than thermalization by Ne. (P.C.H.)

325 OPTIMIZATION OF REACTOR IRRADIATION SCHEDULES FOR RADIOISOTOPES PRODUCTION ACCORDING TO DEMAND. Morales-Amado, A.; Martinez-Leal, A. M. (Comision Nacional de Energia Nuclear, Mexico City). Nucl. Appl., 5: 319-21(Nov. 1968).

Three groups of radioisotopes were studied as a function of demand and production possiblities for different irradiation schedules. The specific activities obtained were compared with postulated demands to establish a method of optimizing the schedules. Two criteria were followed. The first compared the available irradiation volume in the reactor with the theoretically calculated volume that satisfies different demands; the second compared this theoretical volume with the volume needed if the specific activity available from other laboratories is to be used to satisfy the different demands. (auth)

326 OBTAINING ^{103}Ru AND ^{106}Ru FROM FISSION. Villar, M. A.; Barrachina, M. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 527-33 (May 1967). (In Spanish).

Carrier free ^{103}Ru and ^{106}Ru, from uranium oxide irradiated with neutrons, was obtained by a modified Kambara's method previously used in the distillation of Ru from aged solutions of the fission products. The most important contaminant was ^{131}I for which a decontamination factor of 10^2 was obtained. The ruthenium distillation yield was over 98%. The irradiated uranium oxide (U_3O_8) was dissolved in concentrated nitric acid and the fission ruthenium isotopes were distilled from 50% sulfuric acid medium in the presence of lead peroxide as oxidating agent. The oxidation step was effected slowly, by gentle heating, in order to bring the fission halogens to their higher valency states without distillation, afterwards, ruthenium isotopes were distilled off and collected over dilute solution of nitric acid and hydrogen peroxide. Two successive distillations are required to obtain a pure radioactive fission ruthenium solution. (auth)

327 ION MOLECULE REACTIONS IN GASEOUS BENZENE, TOLUENE, AND XYLENES. Giardini-Guidoni, A.; Zocchi, F. (CNEN, Rome. Univ., Rome). Trans. Faraday Soc., 64: 2342-2434(Sept. 1968).

Ion molecule reactions in benzene, toluene, and xylenes were studied in the β ray ion source of a mass spectrometer, up to a pressure of about 0.1 torr. Disappearance rate constants were measured for the primary ions. The dimer ions are the main products at the highest pressure investigated. (auth)

328 BEHAVIOUR OF ^{32}P IN CRYSTALLINE AROMATIC PHOSPHATES. Jovanovic-Kovacevic, O. Z. (Boris Kidric Inst. of Nuclear Science, Beograd, Yugoslovia). Inorg. Nucl. Chem. Lett., 4: 585-90(Oct. 1968).

Data were obtained on the Szilard-Chalmers process in organic phosphate systems, and the chemical behaviour of ^{32}P was compared in crystalline monophenyl and diphenyl phosphates with its behaviour in inorganic solid systems. A number of other phosphorus compounds were also investigated. Details are given of the neutron irradiation, separation and identification of ^{32}P species, annealing, and measurement of ^{32}P activity. Neither phosphine-^{32}P nor any other gaseous product was formed in the systems investigated. Four groups of ^{32}P recoil products were identified. The behaviour was found to be similar to that in inorganic systems, and the experimental upper limit for retention did not exceed 12.7% of the total ^{32}P activity. The appearance of two aliphatic forms with a yield not exceeding 4.9% of the total ^{32}P activity is ascribed to benzene ring breakage. Irradiation conditions considerably influenced the final distribution of ^{32}P in different ionic forms. Isothermal annealing led to an increase in retention and oxidation reactions. There was evidence of thermal as well as radiation annealing. (UK)

329 CONTRIBUTION TO THE RADIOLYTIC STUDY OF TERPHENYLS. I. BEHAVIOR OF THE COMMERCIAL MIXTURE "PROGIL-OM2" WITH FAST ELECTRONS (1 MEV). Pinero, R. Barrera; Rodriguez, J. Manero (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 535-48(May 1967). (In Spanish).

The radiation decomposition of the commercial terphenyl mixture "Progil-OM2" was studied by using 1-MeV electrons, at temperatures ranging from 150 to 350°C, in a completely sealed stainless steel cell fitted with a 0.05 mm thick molybdenum window. The radiolysis was controlled as a dose function by measuring: disappearance of the starting material; evolution of gases; and formation of "high boilers." In general, the results were best fitted by a 1.5 order law for the decomposition/dose curves. The reaction kinetics is discussed and a chain-like reaction mechanism is suggested. With regard to the temperature dependence of G(terf.) and G(→polim.) values, it seems that Arrhenius' Law is followed within the whole range tested. The activation energies calculated were 1.4 and 0.54 Kcal/mole, respectively. However, deviations of this law were found for gas yields. (auth)

330 CONTRIBUTION TO THE RADIOLYTIC STUDY OF TERPHENYLS. II. INFLUENCE OF PARTIAL HYDROGENATION ON THE STABILITY OF COMMERCIAL MIXTURES WITH FAST ELECTRONS (1 MEV). Pinero, R. Barrera; Rodriguez, J. Manero (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 549-56(May 1967). (In Spanish).

The relative radiation stability of several partially hydrogenated terphenyl mixtures under fast electrons (1-MeV) was investigated, the tests being carried out in stainless steel capsules at 200°C. The irradiated samples consisted of mixtures of OM2 (terphenyl nuclear reactor coolant manufactured by "Progil") and HB-40 (40% hydrogenated terphenyl coolant manufactured by "Monsanto"), in which the percentage of hydrogenated phenyl rings ranged from 0 to 44. The results showed that, although the G_{gas} increase with the hydrogenation percentage, the G(→high boilers) values decrease for hydrogenations below about 15%, a minimum being observed at about 10% of hydrogenation. (auth)

331 A STUDY OF THE RELATIONSHIP BETWEEN THE INITIAL RECOIL REACTIONS AND THEIR MEMORY EFFECTS ON THE POST-ANNEALING REACTIONS USING α- AND β-ZINC PHTHALOCYANINES. Yoshihara, Kenji; Yang, Mo-hsiung (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta 9: 168-9(Aug. 1968).

Crystal structure effects on the initial recoil reactions and on the annealing reactions were studied in neutron-irradiated α- and β-zinc phthalocyanines. Comparison of the initial retention ratio with the annealing rate ratio gave information on solid-state recoil chemistry. (M.C.G.)

332 USES OF HIGH-ENERGY RADIATION FOR THE MODIFICATION OF CELLULOSE FIBERS. I. Okada, Toshio. Kobunshi Kako, 17: No. 7, 13-17(July 1968). (In Japanese).

Research concerning the modification of cellulose fibers by high-energy radiations is divided into three parts: improvement in wash and wear qualities, heat setting, etc.; obtaining moisture rejection; and production of elastic yarns with cellulose fibers. Studies and investigations on graft-polymerization of various monomers onto cotton and, graft-polymerization of reactive monomers onto cotton cloth are discussed. (NSA of Japan)

Radiochemistry

Refer also to abstracts 296, 535, and 1969.

333 GASEOUS ELECTRO-DEPOSITION OF DECAY PRODUCTS OF THORIUM. Shinagawa, Mutsuaki (Osaka Univ.); Furushima, Kazuyoshi; Mizumoto, Yoshihiko. J. Nucl. Sci. Technol. (Tokyo), 5: 408-13(Aug. 1968).

Anode and cathode of identical shape and material were suspended above a ThO_2 powder layer in a beaker in atmospheric pressure at room temperature to obtain active deposits containing ThB, etc., on the cathode. Electrode plates were made of either Al, Ti, Ni, Zn, Cd, and Pt, both bare and with active charcoal powder coating. Experimental conditions were varied. The active deposits were examined radiochemically. Results indicated the existence of transient equilibrium among the nuclides. (J.G.B.)

334 EFFECT OF THE REACTORS (n,2n) AND (γ,n) ON FLUOROBENZENE BOTH PURE AND IN SOLUTION. Ledrut, J. H. T.; Point, J.-J. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). Radiochim. Acta, 9: 113-15(Aug. 1968). (In French).

The activation of fluorobenzene by (n,2n) and (γ,n) reactions is studied. The activity is measured in the inorganic fraction, in the total organic fraction, and in the separated fluorobenzene. (auth)

335 METHODS OF PREPARING AND STORING LABELLED COMPOUNDS. Proceedings of the Second International Conference, Brussels, Belgium, November 28–December 3, 1966. Sirchis, J. (ed.). Brussels, European Atomic Energy Community, 1968. 1189p. FB 1250; DM 100; FF 125; Lit. 15.600; Fl. 90; $25.00. (In English and French). (EUR-3746; CONF-661139).

One-hundred papers are included on the preparation and use of labeled compounds. Methods are described for preparing compounds labeled with ^{14}C, ^{11}C, ^{32}P, deuterium, tritium, ^{197}Hg, and ^{203}Hg. Various methods are described for the use of labeled compounds, particularly in metabolic studies. (P.C.H.)

336 ADSORPTION OF THE ^{32}P ACTIVITY FROM AQUEOUS SOLUTIONS ON THE GLASS WALLS OF PACKING VIALS. Zelenay, K.; Radoszewski, T. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 1003-9(1968). (In Polish).

The adsorption of the phosphorus-32 activity from aqueous solutions on the glass walls of packing vials was investigated as a function of storage time, radioactivity, pH-value, and carrier concentration. Conditions for storing and manipulating these solutions without essential losses due to adsorption on the walls of the packing vials were established. (auth)

Separation Processes

Refer also to abstracts 23, 89, 102, 131, 544, 600, 677, 1880, 1968, 2034, and 2053.

337 (BNWL-CC-956) SOLVENT EXTRACTION OF TRANSPLUTONIUM ELEMENTS FROM REDOX WASTE. Roberts, F. P.; Bray, L. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 20, 1966. Contract AT(45-1)-1830. 8p. Dep. CFSTI.

The extraction of Am and Cm, using TBP, from the Shippingport blanket processing wastes from Redox Plant has been studied. The results of laboratory studies using synthetic Redox wastes and hot cell studies using full level Redox waste (including actual Shippingport processing wastes) are described. The high $Al(NO_3)_3$, $NaNO_3$, low-acid waste solution from processing of the Shippingport blanket in the Redox plant is suited for TBP extraction of Am and Cm. Distribution ratios, E^o_a, greater than 100 for both Am and Cm are obtained. The extraction is rapid and maximum distribution ratios are obtained in one minute or less. The effects of pH of the aqueous phase were not studied in detail but maximum distributions appeared to be obtained near pH 1.1. (P.C.H.)

338 (CEA-R-3554) STUDY OF VARIOUS DECONTAMINATION PROCESSES FOR EVAPORATION CONCENTRATES. Lefillatre, Guy; Cudel, Yvonne; Rodi, Lucienne (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Sept. 1968. 48p. (In French). Dep.

Generally speaking, the evaporation concentrates are in the form of acid solutions of high salt content, about 400 g/l. The specific activity is very variable: from 0.5 mCi/l to many hundreds of Ci/l. Because of the high solubility of these salts, an attempt has been made to render the radioelements insoluble in the concentrates before their possible coating with bitumen. With this in view, the possibility of fixing them on inorganic products, of precipitating them in the form of insoluble salts, or of adsorbing them on coprecipitates has been considered. The technique consists of carrying out the precipitations (hydroxides, specific processes for ^{90}Sr and ^{137}Cs) one after the other without separating the precipitates. (auth)

339 (CONF-680426-2) A PROPOSED METHOD, USING BACTERIA, FOR THE CONTINUOUS LEACHING OF A URANIUM ORE. Internal Report EMA 68-5. McCreedy, H. H.; Harrison, V. F.; Gow, W. A. (Department of Energy, Mines and Resources, Ottawa (Ontario). Mines Branch). May 21, 1968. 22p.

From 70th Annual Meeting of Mining and Metallurgy, Vancouver, B. C.

A semicontinuous bench-scale, countercurrent-decantation system, in which the ore was moved countercurrently to the flow of leaching solution, was used to conduct acid-leaching tests on uranium ore with the aid of bacteria. This method, which involved a low degree of agitation, was successfully applied to extract uranium in practical amounts and at practical rates. The acidity of the leaching solution was the main variable investigated in the bench-scale tests done at the Mines Branch, Ottawa. Over 90% of the uranium was extracted in a six-stage system. The results suggest that this technique could be applied in utilization of bacterial oxidation and leaching as a method for treating Elliot Lake uranium ore. (auth)

340 (CU-755-5) SEPARATION OF ISOTOPES. Annual Progress Report. Ghate, M. R.; Goldfrank, J. C.; Smith,

Jessie G.; Garbazevich, J.; Saltamach, V. G.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). Sept. 20, 1968. Contract AT(30-1)-755. 287p. Dep. CFSTI.

Research progress on separation of isotopes is summarized. Topics covered include: production of ^{14}N highly depleted in ^{15}N, concentrating deuterium in a dual temperature system, mass spectrometric determination of deuterium in water, ^{15}N exchange between nitric oxide and nitric acid, and separation and analysis of isotopic species by low-temperature gas chromatography. Separate abstracts were prepared for 3 sections. (M.C.G.)

For abstracts of individual sections see: 341–343.

341 (CU-755-5, Sect. II) NO–HNO_3 EXCHANGE SYSTEM FOR PRODUCTION OF ^{14}N HIGHLY DEPLETED OF ^{15}N. Ghate, Madhav R.; Taylor, T. I. (Columbia Univ., New York. Dept. of Chemistry). 62p.

The isotopic exchange reaction between NO and HNO_3 was used to prepare ^{14}N highly depleted in ^{15}N. This required an efficient reflux system of low hold-up to convert the oxides of nitrogen to nitric by reaction with oxygen and water. A study of the characteristics of the one constructed showed that less than 1 part in 32,000 of the nitric acid was lost from the refluxer as oxides of nitrogen. ^{14}N with an atom fraction of less than 0.00004 ^{15}N was prepared at the rate of about 46g/day. The application of the refluxer to a system for producing ^{15}N is discussed. (auth)

342 (CU-755-5, Sect. III) COMPARISON OF METHYLACETYLENE AND HYDROGEN SULFIDE EXCHANGE WITH WATER FOR CONCENTRATING DEUTERIUM IN A DUAL TEMPERATURE SYSTEM. Goldfrank, J. C. (Columbia Univ., New York. Dept. of Chemistry). 5p.

Deuterium exchange between methylacetylene and water and between hydrogen sulfide and water was investigated in a dual-temperature apparatus. Separation was the greatest in hydrogen sulfide–water exchange. (M.C.G.)

343 (CU-755-5, Sect. V) A STUDY OF THE FACTORS AFFECTING THE RATE OF ^{15}N EXCHANGE BETWEEN NITRIC OXIDE AND NITRIC ACID USING ISOTOPE SEPARATION IN AN EXCHANGE COLUMN. Garbazevich, J.; Taylor, T. I.; Amich, E. H. Jr. (Columbia Univ., New York. Dept. of Chemistry). 203p.

The method used for investigating rates of ^{15}N exchange between NO and HNO_3 is based on determination of the rate of interphase transfer from overall isotope separation in an exchange column. (M.C.G.)

344 (INR-922) APPLICATION OF POLISH DOLOMITE AND PHOSPHORITE FOR THE DECONTAMINATION OF RADIOACTIVE LABORATORY EFFLUENTS. Ksiazak, Zdzislaw; Zarnowiecki, Krzysztof (Institute of Nuclear Research, Warsaw (Poland)). 1968. 27p. (In Polish). Dep.

Decontamination properties of Polish dolomite and phosphorite were examined. As a result of these experiments a special filter for decontamination of radioactive effluents was constructed. (auth)

345 (IS-1900, Paper 2) CHEMICAL ENGINEERING DIVISION. Spedding, F. H.; Burnet, G.; Burkhart, L. E.; Shuck, F. O.; Smutz, M.; Stevenson, F. D. (Ames Lab., Iowa). 13p.

Progress is reported on solvent extraction chemistry, liquid metal studies, halogenation studies, fundamental transfer and transport studies, and reactor materials development. (M.C.G.)

346 (LA-DC-10006) TREATMENT OF HIGHLY RADIOACTIVE WASTES. Christenson, C. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 28p. Dep. CFSTI.

From Basic Training Course in Management of Radioactive Wastes, IAEA–Brazil CNEN, Rio de Janeiro, Oct. 14–25, 1968.

The processing and disposal of radioactive waste at Hanford are discussed. A program was formulated in which wastes that generate very little heat will be evaporated to salt cakes in the existing underground tanks. The self-boiling wastes will be separated into two fractions, one containing the long-lived heat producers for storage in separate high-integrity containers, the other fraction containing all other materials to be solidified eventually as low-heating wastes. The U.K. FINGAL process makes possible the conversion of wastes from the Windscale separation plant into a leach-resistance glass. Research carried out in France on solidification of fission product solutions is reviewed. Hydraulic fracturing is also considered. (M.C.G.)

347 (NP-17553) RECOVERY OF PURE PLUTONIUM: BY EXTRACTION WITH TRILAURYLAMINE AND "DIRECT PRECIPITATION." Van Geel, J. N. C. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Jan. 1968. 119p. (ETR-188). Dep. CFSTI.

A new method for the purification and recovery of Pu, using selective extraction of Pu by tridodecylamine, and precipitation of Pu from the extract as plutonium oxalate is described. The results of continuous liquid-liquid extraction experiments are presented. Methods for improving the decontamination from Ru are discussed. A systematic study of the precipitation of Pu from the organic extract by means of oxalic acid is also presented. From this study, optimum precipitation conditions, resulting in minimum losses of Pu in the mother liquor, are deduced. The influence of certain process variables on the sedimentation characteristics of the precipitate is also discussed. From the data and results, a final flow sheet for the purification and concentration of Pu is proposed. (P.C.H.)

348 (NP-17579, pp VI.7-8) WASTE PROCESSING. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Reprocessing of liquid and solid wastes is discussed. Experiments are being carried out on sea dumping of processed solid waste. There was a steady increase in liquid warm waste volumes. (M.C.G.)

349 (NP-17651) THE SURFACE CHEMISTRY OF CARBON. STUDIES ON THE USE OF CARBON AS AN ADSORBENT IN NUCLEAR REACTORS OF THE AQUEOUS SUSPENSION TYPE. van der Plas, Theo (Technische Hogeschool, Delft (Netherlands)). 1968. 279p. Dep.

Thesis.

Nonvolatile fission products can be removed from the circulating fuel stream of an aqueous homogeneous suspension reactor by continuously supplying adsorbent to the fuel stream and separating the fuel from the suspension in water. Hydrophilic, oxygen-rich carbon blacks are proposed as the adsorbing material. The adsorption of europium (conc.10^{-7} molar) on carbons was investigated and compared with the adsorption on quartz. Europium was strongly bound to the carbon. A functional group was performed on oxygen-containing groups on the carbons. All of the oxygen present can be accounted for, although a number of discrepancies between the results of several of the methods used cannot be resolved. The behaviour under reactor irradiation of suspensions of carbon in water and dilute solutions of sulfuric acid or potassium hydroxide was investigated. Hydrogen and carbon dioxide are produced and some oxygen is fixed on the carbons. (auth)

350 (NSJ-tr-117) REMOVAL OF RADIOACTIVE IODINE VAPOR WITH ION-EXCHANGER. Iwai, Sigehisa; Inoue, Yoriteru; Terasima, Yutaka; Sugawara, Masataka. Translated from Nippon Genshiryoku Gakkaishi, 9: 249-58(May 1967). 22p. Dep.

An abstract was previously prepared and appeared in Nuclear Science Abstracts as 21: 32356. (B.G.D.)

351 (ORNL-4272) CHEMICAL TECHNOLOGY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING MAY 31, 1968. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 304p. Dep. CFSTI.

Nineteen sections are included; a separate abstract was prepared for each. (P.C.H.)

For abstracts of individual sections see: 99–101, 216, 352–365, and 593.

352 (ORNL-4272, pp 1-33) MOLTEN-SALT REACTOR PROCESSING. (Oak Ridge National Lab., Tenn.).

CORROSION—protection against, development of frozen salt layer for
SALTS—use of frozen layers of, for protection against corrosion
REACTOR FUELS—reprocessing of MSBR; preparation of lithium fluoride–uranium tetrafluoride, for MSRE
CERIUM FLUORIDES, LANTHANUM FLUORIDES, NEODYMIUM FLUORIDES, PRASEODYMIUM FLUORIDES; SAMARIUM FLUORIDES, EUROPIUM FLUORIDES, YTTRIUM FLUORIDES, BARIUM FLUORIDES, STRONTIUM FLUORIDES, ZIRCONIUM FLUORIDES, BERYLLIUM FLUORIDES—volatility in mixtures with beryllium fluoride–lithium and lithium fluoride at 1000°C
LITHIUM FLUORIDES—volatility of barium, beryllium, rare earth, strontium, yttrium, and zirconium fluorides in, at 1000°C
BERYLLIUM FLUORIDES—BeF_2–LiF, volatility of barium, beryllium, rare earth, strontium, yttrium, and zirconium fluorides in, at 1000°C
FUSED SALTS—volatilities in systems of, design of transpiration apparatus for measuring
BERYLLIUM FLUORIDES—BeF_2–LiF, activity coefficients, partial pressure, and relative volatilities in, at 1000°C
BERYLLIUM FLUORIDES—BeF_2–LiF–UF_4, activity coefficients, partial pressure, and relative volatilities in, at 1000°C

BERYLLIUM FLUORIDES—BeF_2–LiF–RbF, activity coefficients, partial pressure, and relative volatilities in, at 1000°C
BERYLLIUM FLUORIDES—BeF_2–CsF–LiF, activity coefficients, partial pressure, and relative volatilities in, at 1000°C
BERYLLIUM FLUORIDES—BeF_2–LiF–ZrF_4, activity coefficients, partial pressure, and relative volatilities in, at 1000°C
BERYLLIUM FLUORIDES—BeF_2–LiF–ThF_4, phase studies on, at 1000°C, vapor-liquid
BERYLLIUM FLUORIDES—BeF_2–LiF-base–ZrF_4, distillation rates for MSRE carrier salt of
URANIUM—separation from MSBR salts by reductive extraction using bismuth–lithium solutions; distribution between bismuth–lithium and beryllium fluoride–lithium fluoride solutions at 500 to 700°C; distribution between bismuth–lithium solutions and beryllium fluorides–lithium fluoride–thorium fluoride salts at 500 to 700°C; distribution between bismuth and beryllium fluoride–lithium fluoride–thorium fluoride solutions at 600°C; separation from MSBR salts by reductive extraction using bismuth; volatilization from beryllium fluoride–lithium fluoride–uranium tetrafluoride–zirconium fluoride, corrosion of Hastelloy N during; fluorination in beryllium fluoride–lithium fluoride–uranium tetrafluoride–zirconium fluoride by fluorine–nitrogen mixture, effects of fission products on
RARE EARTHS—separation from MSBR salts by reductive extraction using bismuth–lithium solutions
BERYLLIUM FLUORIDES—BeF_2–LiF, separation of rare earths and uranium from, by reductive extraction using bismuth–lithium solutions
EUROPIUM—distribution between bismuth–lithium and beryllium fluoride–lithium fluoride solutions at 500 to 700°C; distribution between bismuth–lithium solutions and beryllium fluoride–lithium fluoride–thorium fluoride salts at 500 to 700°C; distribution between bismuth and beryllium fluoride–lithium fluoride–thorium fluoride solutions at 600°C
LANTHANUM—distribution between bismuth–lithium and beryllium fluoride–lithium fluoride solutions at 500 to 700°C; distribution between bismuth–lithium solutions and beryllium fluoride–lithium fluoride–thorium fluoride salts at 500 to 700°C;
SODIUM—distribution between bismuth–lithium solutions and beryllium fluoride–lithium fluoride–thorium fluoride salts at 500 to 700°C
THORIUM—distribution between bismuth–lithium solutions and beryllium fluoride–lithium fluoride–thorium fluoride salts at 500 to 700°C; distribution between bismuth and beryllium fluoride–lithium fluoride–thorium fluoride solutions at 600°C; use in reductive extraction method for separating protactinium from molten salts
LITHIUM—distribution between bismuth and beryllium fluoride–lithium fluoride–thorium fluoride solutions at 600°C
BERYLLIUM FLUORIDES—BeF_2–LiF–ThF_4, separation of uranium from, by reductive extraction using bismuth
BISMUTH—use of reductive extraction of uranium from beryllium fluoride–lithium fluoride–thorium fluoride salts; use in reductive extraction method for separating protactinium from molten salts
BISMUTH ALLOYS AND SYSTEMS—Bi–Li, use in reductive extraction of rare earths and uranium from beryllium fluoride–lithium fluoride salts
PROTACTINIUM—separation from two-fluid molten salts in MSBR by reductive extraction using bismuth; separation from molten salts in single-fluid MSBR by reductive extraction using thorium
HASTELLOY N—corrosion by beryllium fluoride–lithium fluoride–uranium tetrafluoride–zirconium fluoride, effects of uranium volatilization on
BERYLLIUM FLUORIDES—BeF_2–LiF–UF_4–ZrF_4, corrosive effects on Hastelloy N, effects of uranium volatilization on
RUTHENIUM-103, NIOBIUM-95, TELLURIUM-132, IODINE-131—effects on uranium fluorination in beryllium fluoride–lithium fluoride–uranium tetrafluoride–zirconium fluoride by fluorine–nitrogen mixture
URANIUM-233—preparation of fuel of, for MSRE
LITHIUM FLUORIDES—LiF–UF_4, preparation of labeled fuels of, for MSRE
REACTOR FUELS—preparation of lithium fluoride–uranium tetrafluoride, for MSRE
NICKEL FLUORIDES—separation from beryllium fluoride–lithium fluoride–zirconium fluoride carrier salt by hydrogen sparging and filtration
IRON FLUORIDES, CHROMIUM FLUORIDES—separation from beryllium fluoride–lithium fluoride–zirconium fluoride carrier salt by reduction by zirconium and filtration
BERYLLIUM FLUORIDES—BeF_2–LiF–ZrF_2, separation of nickel fluorides from, by hydrogen sparging and filtration
BERYLLIUM FLUORIDES—BeF_2–LiF–ZrF_4, separation of chromium and iron fluorides from, by reduction by zirconium and filtration (P.C.H.)

353 (ORNL–4272, pp 34–55) DEVELOPMENT OF AQUEOUS PROCESSES FOR FAST REACTOR FUELS. (Oak Ridge National Lab., Tenn.).

REACTOR FUELS—reprocessing fast, head-end mechanical processes for; shipping LMFBR, cask designs for
SHIPPING—cask designs for, of LMFBR fuels
FISSION PRODUCTS—separation of volatile, from plutonium dioxide–uranium dioxide fuels, heating-oxidation method for
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, separation of volatile fission products from fuels of, heating-oxidation method for; PuO_2–UO_2, dissolution of stainless steel-clad fuels of, by nitric acid
TRITIUM—separation from plutonium dioxide–uranium dioxide fuels, method for
IODINE-131—separation from plutonium dioxide–uranium dioxide fuels, method for; volatility of, during nitric acid dissolution of stainless steel-clad plutonium dioxide–uranium dioxide fuels
NITRIC ACID—solvent properties for stainless steel-clad plutonium dioxide–uranium dioxide fuels; HNO_3–H_2O_2, solvent properties for uranium dioxide; separation of plutonium from, by solvent extraction using TBP in dodecane; separation of plutonium from, by solvent extraction using secondary amines in diethylbenzene; separation of ruthenium and zirconium from, by solvent extraction using irradiated TBP in dodecane
URANIUM OXIDES UO_2—dissolution by hydrogen peroxide–nitric acid solutions
HYDROGEN PEROXIDES—HNO_3–H_2O_2, solvent properties for uranium dioxide
PLUTONIUM—separation from nitric acid by solvent extraction using TBP in dodecane; separation from nitric acid by solvent extraction using secondary amines in diethylbenzene; separation from dodecane–TBP solvent by partitioning using ferrous nitrate and hydrazine; separation from dodecane–TBP solvent by hydrogen reduction in presence of platinum catalyst
PHOSPHORIC ACID, TRIBUTYL ESTER—solvent properties for plutonium in nitric acid; radiolysis of, precipitation of iron and zirconium from nitric acid by products of
AMINES—solvent properties of secondary, for plutonium in nitric acid
DODECANE—dodecane–TBP, separation of plutonium from, by partitioning using ferrous nitrate and hydrazine; dodecane–TBP, separation of plutonium from, by hydrogen reduction in presence of platinum catalyst; dodecane–TBP, radiation effects on solvent properties of, for ruthenium and zirconium in nitric acid solutions; dodecane–TBP, reactions with iodine, products of
IRON NITRATES—use with hydrazine for partitioning plutonium in dodecane–TBP solvents
HYDROGEN—effects on partition of plutonium in dodecane–TBP solutions
RUTHENIUM—separation from nitric acid by solvent extraction using irradiated TBP in dodecane
ZIRCONIUM—separation from nitric acid by solvent extraction using irradiated TBP in dodecane; precipitation from nitric acid by products of radiolysis of TBP
GAMMA RADIATION—effects on solvent properties of dodecane–TBP for ruthenium and zirconium in nitric acid
IRON—precipitation from nitric acid by products of radiolysis of TBP
IODINE—reactions with dodecane–TBP solvent, products of (P.C.H.)

354 (ORNL–4272, pp 56–67) DEVELOPMENT OF PROCESSES FOR HTGR AND LWR FUELS. (Oak Ridge National Lab., Tenn.).

Head-end mechanical methods and the grind-leach process are described for HTGR graphite-base fuels. An inexpensive hack-sawing method was found to be feasible for converting a hexagon-shaped Public Service of Colorado (PSC) fuel block into pieces suitable for feed to a hammer mill or crusher. Hammer milling of sawed graphite PSC prototype fuel yielded a product that could be handled without difficulty and could be introduced easily into a fluidized bed. Hydraulic jet erosion of fuel particles from a prototype PSC fuel stick was readily accomplished with a water jet operating at pressures of about 5000 to 6000 psig. Results of tests indicated that the grind-leach process can probably be applied successfully to HTGR fuels containing pyrolytic-carbon-coated sol-gel oxide particles. Studies of the shear-leach processing of third-generation LWR power reactor fuels were continued. Shear-

ing of a tubular array having a cross section as large as 10 by 10 in. was found to be feasible. Prototype fuel assemblies containing 196, 327, and 484 stainless-steel-clad tubes filled with either porcelain or UO_2 were sheared satisfactorily. (P.C.H.)

355 (ORNL–4272, pp 68-71) FLUORIDE-VOLATILITY PROCESSING. (Oak Ridge National Lab., Tenn.).

URANIUM OXIDES UO_2—processing irradiated fuels of, efficiency of fluidized-bed volatility

NEPTUNIUM FLUORIDES NpF_6—separation from uranium hexafluoride by sorption on calcium, lithium, magnesium, or sodium fluorides

URANIUM FLUORIDES UF_6—separation of neptunium hexafluoride from, by sorption on calcium, lithium, magnesium, or sodium fluorides. (P.C.H.)

356 (ORNL–4272, pp 72-91) WASTE TREATMENT AND DISPOSAL. (Oak Ridge National Lab., Tenn.).

RADIOACTIVE WASTE—disposal of aqueous high-level, by Pot Calcination process; properties of simulated HTGR-Thorex solutions of, as function of boildown and temperature; processing HTGR, burn-leach method for; incorporation of aqueous and organic intermediate level, in asphalt or polyethylene; estimation of, from light water and LMFBR

ASPHALT, ETHYLENE POLYMERS—radioactive waste incorporation in, evaluation of economics and feasibility of intermediate-level

REACTORS, BREEDER; REACTORS, WATER-COOLED—waste from, estimation from

KRYPTON—separation from gases using dimethyl silicone rubber membranes; permeability through dimethyl silicone rubber membrane, effects of gaseous mixture, pressure, and temperature on; separation of nitrogen using dimethyl silicone rubber membranes; separation from argon cover gas from sodium-cooled reactor using dimethyl silicone rubber membranes

XENON—separation from gases using dimethyl silicone rubber membranes; permeability through dimethyl silicone rubber membrane, effects of gaseous mixture, pressure, and temperature on; separation from argon cover gas from sodium-cooled reactor using dimethyl silicone rubber membranes

NITROGEN—permeability through dimethyl silicone rubber membrane, effects of gaseous mixture, pressure, and temperature on; separation of krypton from, using dimethyl silicone rubber membranes

OXYGEN—permeability through dimethyl silicone rubber membrane, effects of gaseous mixture, pressure, and temperature on

ARGON—permeability through dimethyl silicone rubber membrane, effects of gaseous mixture, pressure, and temperature on; separation of krypton and xenon from cover gas of, from sodium-cooled reactor using dimethyl silicone rubber membranes

SILICONE RUBBERS—use of permselective membranes of, for separation of rare gases from gaseous mixtures; performance, size, and economics of cascades of permselective membranes of, for separating krypton and xenon from argon (P.C.H.)

357 (ORNL–4272, pp 92-128) TRANSURANIUM-ELEMENT PROCESSING. (Oak Ridge National Lab., Tenn.).

TRANSURANIUM ELEMENTS—processing and production of, method for; separation of plutonium and zirconium from, by solvent extraction using D2EHPA in diethylbenzene; separation of fission products and rare earths from, modifications in Tramex process for; separation of americium and curium from, lithium chloride-based anion exchange process for

PLUTONIUM—separation from transuranium elements by solvent extraction using D2EHPA in diethylbenzene; separation from D2EHPA in diethylbenzene by reduction, compounds for

CURIUM-244—processing of, modifications in Tramex process for; effects on Zircaloy-2 corrosion by hydrochloric acid and lithium chloride–hydrochloric acid solutions

RARE EARTHS—separation from transplutonium elements, modifications in Tramex process for; separation of, Cleanex process for

AMERICIUM—separation from transcurium elements, lithium chloride-based anion exchange process for; complexes with aminopolyacetic acids, spectra and stability of; separation from californium, curium, and einsteinium by ion exchange using 2-hydroxy-2-methylbutyric acid

CURIUM—separation from transcurium elements, lithium chloride-based anion exchange process for; separation from berkelium in hydrochloric acid by solvent extraction using D2EHPA; separation from americium, californium, and einsteinium by ion exchange using 2-hydroxy-2-methylbutyric acid

ZIRCALOY-2—use as construction material in Transuranium Processing Plant, corrosion studies on; corrosion by hydrochloric acid and hydrochloric acid–nitric acid mixtures

FISSION PRODUCTS—separation from transplutonium elements, modifications in Tramex process for

HYDROCHLORIC ACID—HCl–HNO_3, corrosive effects on Zircaloy-2; corrosive effects of solutions of, containing curium-244 on Zircaloy-2; HCl–LiCl, corrosive effects of solutions of, containing curium-244 on Zircaloy-2

ION EXCHANGERS—development of high-pressure, for use with transuranium elements

CALIFORNIUM—separation from einsteinium and fermium using high-pressure ion exchange column; separation from americium, curium, and einsteinium by ion exchange using 2-hydroxy-2-methylbutyric acid

EINSTEINIUM—separation from californium and fermium using high-pressure ion exchange column; separation from americium, californium, and curium by ion exchange using 2-hydroxy-2-methylbutyric acid

FERMIUM—separation from californium and einsteinium using high-pressure ion exchange column

CALIFORNIUM-249—separation from berkelium-249 using high-pressure ion exchange column

BERKELIUM-249—separation of californium-249, from using high-pressure ion exchange column

CURIUM OXIDES—purification of, method for

ZIRCONIUM—separation from transuranium elements by solvent extraction using D2EHPA in diethylbenzene

HYDROXYLAMINE, ASCORBIC ACID, HYDROQUINONE—hydrochloride, use as reductant in plutonium separation from D2EHPA in diethylbenzene

BERKELIUM—separation from curium in hydrochloric acid by solvent extraction using D2EHPA; separation from transplutonium elements in nitric acid by solvent extraction using D2EHPA in dodecane; oxidation by chromate ions; spectra in heavy water–potassium thiocyanate system and deuterated perchloric and sulfuric acids, absorption

PHOSPHORIC ACID; BIS(2-ETHYLHEXYL) ESTER—separation of plutonium from, by reduction, compounds for; solvent properties for plutonium and zirconium; solvent properties for berkelium and curium in hydrochloric acid

CHROMATES—reactions with berkelium, oxidation

AMERICIUM OXIDES—AmO_2–CmO_2, preparation of sols of, method for; AmO_2–CmO_2, preparation of microspheres of, for HFIR targets

CALIFORNIUM-253—production by irradiation of californium-252, cross sections for

CALIFORNIUM-252—preparation of pellets of, for HFIR targets, method for; preparation of neutron source of, for use in activation analysis

CURIUM OXIDES—AmO_2–CmO_2, preparation of microspheres of, for HFIR targets; AmO_2–CmO_2, preparation of sols of, purification of, method for

CURIUM-248—preparation of pellets of, for HFIR targets, method for

PLUTONIUM-244—preparation of pellets of, for HFIR targets, method for

URANIUM OXIDES U_3O_8—preparation of uranium-236-labeled, for use in rabbit capsules

EUROPIUM SULFATES—complexes of, formation constants for

ACETIC ACID, IMINODI-—complexes with americium, spectra and stability of

ACETIC ACID, [2-HYDROXYETHYL)IMINO] DI-, ACETIC ACID, (ETHYLENEDINITRILO)TETRA-, ACETIC ACID, [(CARBOXYMETHYLIMINO)BIS(ETHYLENENITRILO)] TETRA-, GLYCINE, N-(CARBOXYMETHYL)-N′-(2-HYDROXYETHYL)-N,N′-ETHYLENEDI-, ACETIC ACID, [(CARBOXYMETHYLIMINO]BIS[ETHYLENE[(CARBOXYMETHYL)IMINO]-ETHYLENENITRILO]]TETRA-, ACETIC ACID, [ETHYLENEBIS[(CARBOXYMETHYL)IMINO]ETHYLENENITRILO]] TETRA-ACETIC ACID, [(2-HYDROXYTRIMETHYLENE)DINITRO] TETRA-—complexes with americium, spectra and stability of

BUTYRIC ACID, 2-HYDROXY-2-METHYL-—use as eluant in ion exchange separation of americium, californium, curium, and einsteinium

PLUTONIUM OXIDES PuO_2—electron diffraction of aged colloidal solutions of (P.C.H.)

358 (ORNL–4272, pp 129-41) DEVELOPMENT OF THE THORIUM FUEL CYCLE. (Oak Ridge National Lab., Tenn.).

The preparation of ThO_2–UO_3 hydrosol by solvent extraction was demonstrated. The production rate was 1 kg of contained oxide per hour. The Th-to-U mole ratio was 3, which is in the range of interest for use in HTGR fuel elements. Dispersers for

forming controlled-size sol droplets have been further developed. The design of the pilot plant for preparing large samples of microspheres and for process demonstration has been simplified by eliminating all of the pumps except one. The chemical reactions occurring among the 2-ethyl-1-hexanol drying alcohol, the sol, the nitric acid present in the sol, and the surfactants employed have been studied. Although very complex, these reactions are now understood in a limited sense, and this understanding has led to some process improvements. ORNL serves as a national storage, purification, and distribution center for ^{233}U. During the past year, 118 kg of ^{233}U (22 shipments) was received and 115 kg of ^{233}U (17 shipments) was disbursed by the center. Also, a special storage facility for 1100 kg of U (75% ^{235}U, 11% ^{233}U) as uranyl nitrate solution was built. (P.C.H.)

359 (ORNL–4272, pp 142–60) SOL-GEL PROCESSES FOR THE URANIUM FUEL CYCLE. (Oak Ridge National Lab., Tenn.).

URANIUM OXIDES UO_2—preparation of sols of, by amine solvent extraction process; preparation of porous microspheres of, method for

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, preparation of sols of, precipitation-peptization method for; PuO_2–UO_2, preparation of microspheres of; PuO_2–ZrO_2, preparation of microspheres of

THORIUM OXIDES ThO_2—preparation of microspheres of, equipment and method for; ThO_2–UO_2, preparation of porous microspheres of, method for

THORIUM CARBIDES—ThC_2–UC, preparation of microspheres of, by conversion of oxide gels

THORIUM OXIDES ThO_2—C–ThO_2, preparation and properties of sols of (P.C.H.)

360 (ORNL–4272, pp 161–73) SOL-GEL PROCESSES FOR ISOTOPIC HEAT SOURCES. (Oak Ridge National Lab., Tenn.).

A procedure was developed for preparing dense $^{238}PuO_2$ microspheres. Sphere formation, drying, and calcination were successful. The quality of the product is discussed. Equipment for the preparation of $^{238}PuO_2$ sols and for the subsequent forming, drying, and firing to dense $^{238}PuO_2$ microspheres was fabricated, installed in a stainless steel cubicle, and shipped to Mound Laboratory. The production capacity of the unit is one batch, containing 150 g of Pu, per 24 hr. Mixed ^{244}Cm–^{243}Am oxide microspheres (84% curium) were successfully prepared on a 4- to 10-g scale. Purification of feed material, by oxalate precipitation and calcination, was found to be necessary. The final microspheres were free flowing, dust free, and showed no tendency to crack or disintegrate. (P.C.H.)

361 (ORNL–4272, pp 174–86) SEPARATIONS CHEMISTRY RESEARCH. (Oak Ridge National Lab., Tenn.).

VANADIUM, HAFNIUM—separation from acidified lithium sulfate solutions by solvent extraction using amines in diethylbenzene

LITHIUM SULFATES—separation of hafnium and vanadium from acidified solutions of, by solvent extraction using amines in diethylbenzene

AMINES—solvent properties for hafnium and vanadium in acidified lithium sulfate solutions

LITHIUM—separation from potassium and sodium by solvent extraction using β-diketones; separation from alkaline chloride solutions by solvent extraction using β-diketones

POTASSIUM—separation of lithium from, by solvent extraction using β-diketones; separation from alkaline chloride solutions by solvent extraction using β-diketones

SODIUM—separation of lithium from, by solvent extraction using β-diketones; separation from alkaline chloride solutions by solvent extraction using β-diketones; separation from sodium nitrate solutions by solvent extraction using carboxyl acid compound

DIKETONES—solvent properties for lithium, potassium, and sodium

BERYLLIUM—separation from sodium carbonate solutions by solvent extraction using substituted ammonium compounds

SODIUM CARBONATES—separation of beryllium from, by solvent extraction using substituted ammonium compounds

AMMONIUM COMPOUNDS, SUBSTITUTED—solvent properties for beryllium in sodium carbonate solutions

URANIUM—separation from phosphoric acid by solvent extraction using D2EHPA–TOPO mixture

PHOSPHORIC ACID—separation of uranium from, by solvent extraction using D2EHPA–TOPO mixture

PHOSPHORIC ACID, BIS(2-ETHYLHEXYL) ESTER—D2EHPA–TOPO, solvent properties for uranium in phosphoric acid solutions

STRONTIUM—separation from sodium nitrate solutions by solvent extraction using carboxylic acid compound

SODIUM NITRATES—separation of sodium and strontium from solutions of, by solvent extraction using carboxylic acid compound

IRON—separation from aqueous perchlorate solutions by solvent extraction using D2EHPA in octane

PERCHLORATES—separation of iron from aqueous solutions of, by solvent extraction using D2EHPA in octane

PHOSPHORIC ACID, BIS(2-ETHYLHEXYL) ESTER—solvent properties for iron in aqueous perchlorate solutions

WATER—solubility in benzene solutions of trioctylamine

TRIOCTYLAMINE—solvent properties of benzene solutions of, for water

362 (ORNL–4272, pp 187–91) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on copper ores and recovery of oil from shale. Small-scale tests have indicated that ^{106}Ru is probably the only radioisotope of importance with respect to radiocontamination of cement copper produced from ore broken by a nuclear blast. Copper products essentially free of Ru were produced by dissolving contaminated cement copper in H_2SO_4 and electrolyzing the solution to deposit the Cu on a copper anode. Treating the cell electrolyte with ozone to volatilize Ru offers a means of limiting the ^{106}Ru buildup in the electrolyte. Preliminary tests indicated that the contamination of shale oil by fission products should not be a serious obstacle to using a nuclear device to break the shale prior to in situ retorting. Although oil heated with test-shot debris was slightly contaminated, the radioactive material remained in the pot residue when the oil was distilled. Most of the radioactive material present in the oil was in the form of finely dispersed solids. The problem of tritium contamination of the oil appears to be more serious. (P.C.H.)

363 (ORNL–4272, pp 192–217) BIOCHEMICAL SEPARATIONS. (Oak Ridge National Lab., Tenn.).

ACRYLAMIDE POLYMERS—use of gel columns of, for chromatographic separation of transfer RNA

BODY FLUIDS—analysis for low-molecular-weight constituents of, development of carbohydrate and uv analyzers for

CARBOHYDRATES—determination in body fluids, development of equipment for; determination of excretion rate of, in urine, instruments for

STYRENE POLYMERS—divinylbenzene–polystyrene, sorptive properties for constituents in body fluids, effects of chloromethylation and cross-linkage on

SPECTROPHOTOMETERS—development of double-beam uv, for determination of constituents in body fluids

INSTRUMENTS—development for determination of constituents in body fluids

CHROMATOGRAPHY—effects of column dimensions on column resolution

URINE—analysis for constituents, instruments for (P.C.H.)

364 (ORNL–4272, pp 221–4) CHEMICAL ENGINEERING RESEARCH. (Oak Ridge National Lab., Tenn.).

The 18-state (14 extraction and 4 polishing states) prototype stacked-clone solvent extraction contactor has been tested with simulated first-cycle LMFBR fuel processing solutions. Extraction operations using hydroclones are being evaluated for inclusion in the LMFBR conceptual reprocessing plant. Recent performance data, in addition to data from simulated LMFBR processing runs, are tabulated. Tests of existing stacked-clone contactors with a variety of solutions that represent a wide range of physical properties are being made in both the aqueous- and organic-phase-continuous modes of operation. (P.C.H.)

365 (ORNL–4272, pp 225–37) REACTOR EVALUATION STUDIES. (Oak Ridge National Lab., Tenn.).

Studies were made of various advanced reactor and fuel-cycle systems to determine engineering and economic feasibility. This includes cost studies of shipping fresh and spent nuclear fuel, reprocessing spent fuel, and preparing various virgin and recycle fuel materials (oxides, metals, fluorides, etc.) primarily in support of the USAEC evaluation of civilian nuclear power for the period 1970 to 2020. Computer codes were developed to calculate rational growth patterns for the fuel cycle industry and to make projections of cost vs time for the various steps in the fuel cycle, based on both marketplace (nonoptimal and optimal economic models. A computer code, RIBDOR, was written to calculate activities and concentrations of individual fission product isotopes, fission product elements, groups of chemically similar elements, and their gross totals, as well as beta and γ decay heat release rates. The program also calculates gamma photon release rates in terms of 16 energy groups for use in shielding calculations. (auth)

366 (ORNL–4306, pp 46–57) ISOTOPE CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Developments are reported for studies on: separation of boron isotopes; fractionation of carbon isotopes in the cuprous chloride–ammonium chloride–carbon monoxide system; a liquid–liquid system for enrichment of ^{13}C; vapor pressure of the system dimethylamine–carbon dioxide; ^{17}O facility; photochemical separation of isotopes; chemical fractionation of the isotopes of uranium; molecular spectroscopy; and isotopic mass spectrometry. (P.C.H.)

367 (TID-24745) BIBLIOGRAPHY OF CEN PYROMETALLURGICAL AND PYROCHEMICAL FUEL REPROCESSING WORK. Arntzen, J. (Argonne National Lab., Ill.). Jan. 15, 1968. 45p. Dep. CFSTI.

Two hundred and two references to work performed by the Chemical Engineering Division on high-temperature fuel reprocessing are presented for 1953 through 1967. The references are listed chronologically by year and alphabetically by author within each year. The references are then cross-indexed by author. A listing of other reference sources is included. (M.C.G.)

368 PRECIPITATION OF BERKELIUM(IV) IODATE FROM HOMOGENEOUS SOLUTION. Weaver, Boyd (Oak Ridge National Lab., Tenn.). Anal. Chem., 40: 1894-6(Oct. 1968).

A study is reported that established the coprecipitation of tracer-level Bk with Ce, compared the completeness of precipitation of these two elements, and measured the degree of contamination by several other elements, especially trivalent lanthanides and actinides. Some applications of the technique of precipitating berkelium iodate from homogeneous solutions are: separation of Bk from other transplutonium elements after they are separated from fission products and plutonium, and since ^{249}Bk decays to ^{249}Cf, recovery of ^{249}Cf as a solution after coprecipitating the Bk with Ce. (D.H.M.)

369 INVESTIGATION OF THE INTERACTION OF ^{35}S AND ^{32}P IN WATER–ALCOHOL SOLUTIONS WITH HYDROCHLORIDE OF n-TETRADECYLAMINE BY THE FOAM FORMATION METHOD. Pushkarev, V. V.; Berezyuk, V. G. Radiokhimiya, 10: 433-8(1968). (In Russian).

The separation of microquantities of ^{35}S and ^{32}P as the anions SO_4^{2-} and PO_4^{3-} from aqueous solutions by the foaming method using cation-active hydrochlorides of n-tetradecylamine was investigated. The dependence of the logarithm of the distribution of isotopes between the solutions on the concentration of hydrogen ions and anion salts is described by equations arising as a result of the effective mass law. (R.V.J.)

370 SEPARATION OF TECHNETIUM (^{99m}Tc) AND MOLYBDENUM (^{99}Mo) BY THE EXTRACTION METHOD IN THE TBHP–TBPF–HCl SYSTEM. Gavrilov, K. A.; Mikul'ski, J.; Wang, T'ung-seng Radiokhimiya, 10: 350-4(1968). (In Russian).

By means of reactions with multicharged ions or thermal neutron capture by Mo, active samples of ^{99}Mo and ^{99}Tc were produced and purified by ion exchange. Formulas were derived for the simultaneous calculation of the distribution coefficients of ^{99}Mo and ^{99m}Tc, beginning with the decay scheme of ^{99}Mo. The optimum conditions for the separation of Mo and Tc for extraction in the tetrabutyl hypophosphate–tetrabutyl pyrophosphate–HCl system were determined. (tr-auth)

371 SEPARATION OF NUCLEAR ISOMERS OF ^{127m}Te AND STUDY OF THE CHEMICAL EFFECTS OF THE ISOMERIC CONVERSION OF ^{127m}Te IN THE TELLURATE STATE. Kirin, I. S.; Zaitsev, V. M.; Gusel'nikov, V. S. Radiokhimiya, 10: 354-8(1968). (In Russian).

A simple and effective method for the separation of the nuclear isomers of Te and the production of carrier-free ^{127}Te was proposed using paper chromatography and lamellar chromatography. The chemical effects of the isomeric conversion of ^{127m}Te in the orthotellurates of alkali metals and tellurates of ammonium and monovalent Tl were investigated under various conditions. It was established that increase of the yield of ^{127}Te in the ground state in the tetravalent form occurs in the presence of agents capable of playing a reducing role (ammonium cations, monovalent Tl, and water). (tr-auth)

372 PRECIPITATION OF NIOBIUM AND TANTALUM WITH SALICYLFLUORONE FROM TARTARIC-HYDROCHLORIC ACID AND FLUORIDE-HYDROCHLORIC ACID SOLUTIONS. Zaikovskii, F. V.; Furtova, E. V.; Ivanova, V. N. (All-Union Scientific-Research Inst. of Mineral Raw Material, Moscow). Zh. Anal. Khim., 23: 1232-4(Aug. 1968). (In Russian).

Precipitation of niobium and tantalum from tartaric–hydrochloric acid and fluoride–hydrochloric acid solutions was studied. Zirconium interferes in the precipitation of niobium and tantalum from tartaric-hydrochloric acid solutions; tungsten precipitates with niobium and tantalum from fluoride–hydrochloric acid solutions. The methods developed can be used for separating microgram amounts of niobium and tantalum from large amounts of accompanying elements, from tungsten (the first method) and from zirconium, iron, and other elements (the second method). (auth)

373 EXTRACTION OF RADIOGOLD AND RADIOMERCURY AND SOME OTHER RADIOISOTOPES WITH MESITYL OXIDE. Alian, A. (Atomic Energy Establishment, Cairo). Mikrochim. Acta, No. 5, 988-91(1968).

The extraction of many elements from nitric, hydrochloric, and sulfuric acid media has been studied with mesityl oxide. Highest extraction from the three acidic media was obtained for gold and mercury. Optimum conditions for the separation of these two elements from most other elements were determined. (auth)

374 EXTRACTION OF THORIUM AND CERIUM(III) CHLORIDES BY NEUTRAL ORGANOPHOSPHORUS SOLVENTS. Alian, A. (Atomic Energy Establishment, Cairo); Zaborenko, K. B. Z. Anal. Chem., 238: 267-73(1968).

The extraction of Th and Ce(III) chlorides by tri-n-butyl phosphate and di-isoamylmethyl phosphonate was investigated as a function of HCl molarity in the aqueous phase and solvent concentration in the organic phase. The comparative stability of the extractable metal complexes with the two solvents was also estimated. The second solvent was recommended, for the separation of Th and the rare earth elements from HCl media. (auth)

375 CHLORINATION VOLATILITY SEPARATION OF THORIUM AND URANIUM. Sood, S. P.; Hariharan, A. V. (Bhabha Atomic Research Centre, Trombay, India). pp 321-7 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

A direct chlorination volatility scheme for the separation of thorium and uranium from $ThO_2–UO_2$ reactor fuel material is being investigated. In this process thorium and uranium are converted to the chlorides by chlorination of the oxide at 700 to 750°C using a chlorine–nitrogen gas stream saturated with carbon tetrachloride. Separation is effected by techniques such as high temperature vaporization, filtration, and distillation. The $ThCl_4$ fraction was filtered in a series of two refractory alumina downflow filters and the uranium chlorides were collected in a heated sodium chloride bed. Process variables such as chlorination temperatures, time, gas stream compositions, filter bed, and collection bed temperatures were studied and optimized. The behavior of typical fission products in irradiated $ThO_2–UO_2$ fuel material in the separation scheme is being investigated. (auth)

376 ACETIC ACID AS AN ELUTING AGENT FOR PLUTONIUM(IV) FROM ANION EXCHANGE RESINS. Laxminarayanan, T. S.; Murthy, Y. S.; Singh, R. K.; Kapoor, S. C.; Haraprakash, B.; Narayanan, C. V. (Bhabha Atomic Research Centre, Trombay, India). pp 328-34 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

In the reprocessing of irradiated uranium by the "Purex" process, final purification of plutonium is done by anion exchange resin. In a laboratory study acetic acid, instead of 0.5M HNO_3, was used as an eluting agent. Elution data on plutonium concentrations obtained are presented for different eluting concentrations of acetic acid at two different flow rates. Decontamination factors for uranium and fission products activity are also given. Miscellaneous data are presented for the influence of acetic acid on plutonium loading capacity of the resin after several cycles of operations; the effect of the presence of acetic acid on plutonium, uranium, and fission products during loading and washing cycles; and the precipitation behavior of plutonium as oxalate in the presence of acetic acid. From the data obtained, acetic acid seems to be a better eluting agent than 0.5M HNO_3 for elution of plutonium from anion exchange resin. Maximum concentrations of up to 80 grams of plutonium/liter are obtained and better performances regarding absence of tailing is also noted. Under proper conditions the presence of acetic acid does not hinder the precipitation of plutonium as oxalate. The data are essential since eluted plutonium is converted to plutonium oxide after precipitation as plutonium oxalate. (auth)

377 LABORATORY STUDIES ON THE USE OF URANIUM(IV) IN THE PUREX PROCESS. I. PREPARATION OF U(IV) SOLUTIONS. Ramaniah, M. V.; Rao, C. L.; Pisharody, K. P. R.; Jadhav, A. V.; Viswanatha, A. (Bhabha Atomic Research Centre, Trombay, India). pp 335-42 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A study of the conditions for electrolytic reduction of uranium(VI) to uranium(IV), with hydrazine as the stabilizer was made with tantalum and mercury cathodes in a perspex cell with the anode and the cathode compartments separated by a cation exchange or microporous poly(vinylchloride) membrane. Contrary to the literature data, tantalum was observed to be very inefficient at all experimental conditions. From the studies of the dependence of current efficiency on the current density, nitric acid and uranium(VI) concentration, nearly 100% current efficiency was achieved using mercury cathode and platinum anode. In a two compartment glass cell, several two liter batches of 1 M uranium(VI) in 4 M nitric acid were completely reduced with an average current efficiency of 85% using 50 ma/cm^2 current density. (auth)

378 LABORATORY STUDIES ON THE USE OF U(IV) IN THE PUREX PROCESS. II. USE OF URANIUM(IV) AS THE REDUCTANT FOR PLUTONIUM. Ramaniah, M. V.; Rao, C. L.; Pisharody, K. P. R.; Jadhav, A. V.; Vishwanatha, A. (Bhabha Atomic Research Centre, Trombay, India). pp 343-50 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The stability of uranium(IV) solutions has been studied as a function of nitric acid, hydrazine, and uranium(IV) concentrations. The stability of uranium(IV) in TBP solutions was also studied. The partition coefficients for uranium(IV) nitrate in 30% TBP in kerosene as well as in uranium-loaded TBP in kerosene were determined. The dependence of the partition coefficients for uranium(IV) on the uranium(VI) concentration in the aqueous phase was also studied. The stripping of plutonium from TBP using uranium(IV) in nitric acid was studied by batch equilibration and the optimum nitric acid and uranium(IV) concentrations in the strip solutions are reported. (auth)

379 LABORATORY STUDIES ON PARTITIONING OF PLUTONIUM FROM URANIUM BY REDUCTION TO Pu(III) WITH FERROUS AND HYDRAZINE IN PUREX PROCESS. Nadkarni, M. N.; Mani, V. V. S.; Ramanujam, A.; Lal, Gulashan; Kulkarni, R. T. (Bhabha Atomic Research Centre, Trombay, India). pp 351-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

During the partitioning step in the Purex Process by backextraction of plutonium into the aqueous phase from the organic solvent, Pu(IV) is reduced to Pu(III), which has a very low distribution coefficient in the organic solvent, 30% TBP. Reductants such as ferrous sulfamate, hydrazine, and hydroxylamine were used. Different parameters affecting the partition of plutonium, viz., aqueous acidity, concentration of reductants, and the number of contacts were studied for both the reductants. At a low acidity of 0.5N nitric acid, 0.03N ferrous sulfamate showed 99% plutonium backextraction into the aqueous phase but uranium stripped was also found to be quite considerable (24.6%). At the higher acidity (1.5N) plutonium partitioning was not much impaired but the fraction of uranium stripped was markedly lower. Reduction of plutonium with hydrazine was not satisfactory due to poor kinetics. Backextraction of uranium was notably suppressed by increasing the hydrazine molarity (up to 8N). Increasing the concentration of hydrazine from 0.3 to 8N in a 0.03N Fe^{2+}, 1.5N HNO_3 solution did not affect the backextraction of plutonium but uranium backextraction decreased considerably thereby improving the plutonium/uranium ratio in the aqueous product after partition. (auth)

380 OXIDATION OF FERROUS SULPHAMATE IN NITRIC ACID SOLUTIONS. Iyer, R. S.; Laul, J. C.; Ramaniah, M. V.; Rao, C. L.; Srinivasan, N. (Bhabha Atomic Research Centre, Trombay, India). pp 359-65 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The rates of oxidation of ferrous sulfamate in fuel reprocessing cycles in nitric acid solutions at temperatures 27, 60, and 96°C were studied at various concentrations of nitric acid and ferrous sulfamate. The half-times and rate constants under these conditions and the activation energy for the reaction were determined. (auth)

381 STUDIES ON THE CHEMICAL AND RADIOCHEMICAL SEPARATION OF THORIUM. Sethi, Suman; Rai, Rama Shanker (Univ. of Rajasthan, Jaipur, India). pp 366-75 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A laboratory procedure was developed for the separation of thorium from phosphate, calcium, and iron(III) using a heterogeneous exchange reaction and mixed crystal formation. Distribution values for these ions were determined using a precipitate of bismuth iodate or periodate in excess of iodate or periodate ions. A solution containing a sufficient amount of a mixture of thorium, calcium, iron, and phosphate ions is added on a bed of precipitate. The amount of thorium taken up is about 99%. This value was obtained both by colorimetric analysis using thoron and by tracer technique using Ux_1. The adsorption of phosphate is only 50% on the precipitate. The uptake of Fe(III) by bismuth iodate is 69% and by bismuth periodate is 87%. Calcium flows down the precipitate bed and 100% separated. Bismuth and the remaining amount of Fe(III) and phosphate are separated from thorium and conditions were investigated to ensure minimum interference in the separation. Effects of the fresh and aged precipitates on the nature of the uptake of thorium were also investigated. The loss in the final recovery of thorium is about 1%. (auth)

382 RAPID MILKING OF ^{211}Pb FROM ^{223}Ra ON CATION EXCHANGE RESIN EMPLOYING $(NH_4)_2H_2$ EDTA. Ephraim, D. C.; Bhatki, K. S. (Tata Inst. of Fundamental Research, Bombay). pp 386-90 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The separation of ^{211}Pb from ^{223}Ra on a small column of Dowex 50W-X8 cation exchange resin employing solutions of the diammonium salt of EDTA is described. Solutions of various concentrations from 0.025 to 0.1M EDTA were also studied to see their effect on the milking of ^{211}Pb from ^{223}Ra. (auth)

383 SEPARATION OF ACTINIDES AND LANTHANIDES USING DI(2-ETHYLHEXYL) PHOSPHORIC ACID. Khopkar, P. K.; Narayanankutty, P. (Bhabha Atomic Research Centre, Trombay, India). pp 391-7 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A method for separation of trivalent actinides and lanthanides by solvent extraction using di(2-ethylhexyl) phosphoric acid (HDEHP) in xylene from 10M calcium chloride is given. A separation factor of 100 between the Am(III)–Eu(III) pair was obtained, which compares favorably with existing methods. The use of calcium chloride avoids the neutron hazards associated with concentrated lithium chloride solution in contact with alpha emitters. The effects of variation of calcium chloride concentration, pH, and the concentration of HDEHP on the separation factor obtained were studied. A possible mechanism responsible for achieving this separation is discussed. (auth)

384 STUDIES ON THE EXTRACTIVE BEHAVIOUR OF HETEROPOLY ACIDS. PART IV. EXTRACTION OF PHOSPHOMOLYBDIC ACID WITH QUINOLINE IN ORGANIC DILUENTS. Lakshmanan, V. I.; Haldar, B. C. (Inst. of Science, Bombay). pp 398-404 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The extractive behavior of phosphomolybdic acid with quinoline in organic diluents was investigated. The extraction of phosphomolybdic acid depends on the dielectric constant of diluents and is independent of the added sulfuric acid in the aqueous phase. The plot of log E vs log [Q], where E and [Q] represent extraction coefficient and concentration of quinoline, respectively, gives a slope of three, indicating that the extracted species contain three molecules of quinoline per molecule of phosphomolybdic acid. Extraction studies with nitrobenzene as diluent reveal that the extraction with quinoline is better than that with TBP. The mechanism of the extraction process is discussed. (auth)

385 ION EXCHANGE STUDIES WITH ZIRCONIUM PHOSPHATE. Jadhav, A. V.; Rao, C. L.; Shahani, C. J. (Bhabha Atomic Research Centre, Trombay, India). pp 436-43 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Distribution coefficients for cesium, strontium, and ruthenium in HCl, HNO_3, and $HClO_4$ media and for cerium(III) in HCl and HNO_3 media on amorphous zirconium phosphate were determined over a range of 0.1 to 10M acid concentration. In general, the behavior of these ions at the different acidities studied was observed to be almost identical. Cerium, however, was to some extent less strongly sorbed in $HClO_4$ than in other acids. (auth)

386 MILKING OF ^{90}Y FROM ^{90}Sr EMPLOYING CATION EXCHANGE RESIN. Rane, A. T.; Phatak, V. B. (Tata Inst. of

Fundamental Research, Bombay). pp 211-16 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.
See CONF-670335.

A systematic study, employing Dowex-50W-X8 resin, semi-molar lactate and glycolate solutions at various pH, undertaken to milk ^{90}Y from ^{90}Sr, is reported. The distribution coefficients of strontium and yttrium in Dowex 50W-X8 resin and lactate and glycolate solutions are determined and the results obtained are compared. (auth)

387 SUBSTITUTED ETHAN PHOSPHONIC ACID ESTERS AS REAGENTS FOR THE SEPARATION OF MOLYBDENUM FROM RHENIUM BY SOLVENT EXTRACTION. Jordanov, N.; Mareva, St.; Borisov, G.; Jordanov, B. (Inst. of General and Inorganic Chemistry, Sofia. Inst. of Organic Chemistry, Sofia). Talanta, 15: 221-7(Feb. 1968).

New esters of the ethan phosphonic acids were synthesized and their extraction properties studied with respect to Mo(VI), Re(VII), Fe(III), Au(III), Tl(III), and Sb(V). A possibility is shown for the analytical separation of molybdenum from rhenium (β = 700). The state of these new extraction agents in carbon tetrachloride solution, and the mechanism of the extraction processes, were investigated by means of infrared spectra. (auth) (UK)

388 A NEW METHOD OF OPENING UP MONAZITE. Joseph, P. T.; Mony, C. N. (Univ. of Kerala, India). Chem. Ind. (London), No. 41, 1400(Oct. 12, 1968).

The method described employs ammonium fluoride for processing powdered monazite. This reagent is stated to be as effective and more convenient than the bifluoride. Details are given for the separation of thorium, cerium, and rare earth compounds. (UK)

389 PROCESS FOR SEPARATING FROM ORGANIC LIQUID MODERATOR-COOLANTS LIQUID CHEMICAL PRODUCTS BOILING AT HIGH TEMPERATURES. Cardozo, Raphael Lopes; Van Velzen, Daniel (to EURATOM). British Patent 1,129,211. Oct. 2, 1968. Priority date Feb. 9, 1965, Belgium.

A liquid–liquid extraction method is described for the separation of high-boiling liquids from the organic liquids used as moderator-coolants in nuclear reactors. The liquid moderator coolant is usually composed mainly of terphenyl; and alcohols, aldehydes, aromatic hydrocarbons, esters, ethers, ketones, aliphatic hydrocarbons, or a a mixture of these alone or mixed with water serves as an extractant for the high boiling components. (B.L.M.)

390 URANIUM EXTRACTION WITH TRI-N-BUTYL-PHOSPHATE. David, B.; Filip, Gh.; Vacariu, V.; Tataru, S. Rev. Chim. (Bucharest), 19: 459-63(Aug. 1968). (In Rumanian).

Problems in the purification of uranium concentrates by TBP extraction are discussed. A study has been carried out to determine the influence of the concentration of the uranium, nitric acid, and TBP on the extraction of uranium from nitric acid solutions. The results obtained experimentally with industrial nitric solutions are pointed out. The behavior of the Romanian-made TBP products has been studied and compared with two imported products frequently used in the uranium industry, emphasizing the qualities of the former. The results obtained may be used to achieve some technological flows for the purification of uranium concentrates and show the possibility of using TBP in the uranium industry. (auth)

391 UPTAKE OF URANIUM(VI) ION ON ALKALINE EARTH SULPHATES. Zaki, M. R.; El-Moneim, I. Abd (Atomic Energy Establishment, Inshas, Egypt). Z. Anorg. Allg. Chem., 356: 89-95(1967).

The uptake of uranium(VI) ion on alkaline earth sulfates was studied in hydrochloric acid media of normality ranging from 0.5 to 5.0. Calcium sulfate could not fix uranium through the whole investigated acid range. No uranium was taken up on strontium or barium sulfate from hydrochloric acid solutions of normalities higher than 3. Aging of precipitates and heating of solutions reduced the uptake. The mechanism of uptake of uranyl ion on alkaline earth sulfates is discussed. The isotherms obtained on using barium sulfate were found to obey the Freundlich equation. (auth)

392 STUDIES ON THE FERRON COMPLEXES OF MOLYBDENUM(VI). Rao, V. Pandu Ranga; Rao, K. Venugopala (Andhra Univ., Waltair, India). J. Inorg. Nucl. Chem., 30: 2445-50(Sept. 1968).

Molybdenum(VI) and ferron combine in 0.2 N acid medium to give a yellow product which can be extracted quantitatively into cyclohexanol. Spectrophotometric investigations revealed that the complex in the aqueous phase has molybdenum(VI) and ferron in 1:1 ratio, while the extracted species is Mo·Ferron$_2$·3 cyclohexanol. The formation constants and the free energies of formation of the complexes were calculated. A photometric method was developed based on the complexation and extraction. Iron(III), copper (II), vanadium(V), and tungsten(VI) interfere. Iron(III) can be masked with pyrophosphate. The tolerance limits for the other three are given. The optimum range with minimum error following Beer's law is 3.5 to 15.0 μ/g of molybdenum per ml. (auth) (UK)

393 REPROCESSING OF CONSUMED FUEL. Oszuszky, Friedrich. Elektrotech. Maschinenbau, 85: 254-6(May 1968). (In German).

The significance of reprocessing and reuse of U and Pu in economic terms is noted; in each individual case reprocessed U may be immediately prepared for reactors consuming that level of activity of U, enriched by gas diffusion, or mixed with higher activity material. A possible alternative is consumption of Pu. Prospects for the amount of reprocessing by 1980 reach 2500 tons for Germany alone, and reprocessing capabilities presently available or planned are viewed in light of meeting such requirements. Control of fission products and price control in Europe are reviewed. Need for more reprocessing plants to lower the cost of reprocessed fuel, coordination, and centralization of fuel cycles of industries will become important in the near future. (BBB)

394 PROCESS AND APPARATUS FOR MODIFYING THE OXYGEN ISOTOPES RATIO BY INCREASING THE HEAVY ISOTOPES PROPORTION. (to Compagnie Francaise de Raffinage). British Patent 1,127,648. Sept. 18, 1968. Priority date Dec. 2, 1964, Switzerland.

A process for the separation of oxygen isotopes is based on the differences of speed of migration of the ions in an electrolyte in an electric field. The O_2 is passed successively into the cathode chamber of each of a series of electrolytic and/or fuel cells. The interior of the cells is heated to the working temperature, and each cell is composed of the solid electrolyte made of ZrO_2, ThO_2, or HfO_2. The O_2 is ionized at the cathode, and the ions thus obtained are conveyed through the electrolyte into the anode chamber. The O_2 remaining in the cathode chamber is enriched in the heavier isotopes, and except in the last cell in the series the enriched O is passed to the cathode chamber of another cell. The chambers of each cell are separated by a wall composed or at least partially composed of the solid electrolyte. (B.L.M.)

395 EXTRACTION PROCESSES AND THEIR MATHEMATICAL DESCRIPTION. Rozen, A. M. (Cybernetics Council, Moscow). At. Energy Rev., 6: No. 2, 59-135(1968).

The quantitative laws governing extraction processes, the theory of extraction equilibria, calculations of the distribution and purification of substances in multistage (primarily radiochemical) extraction cascades, hydrodynamics and mass transfer in extractors, and the problem of scaling up extraction apparatus by means of models are discussed. The review is based on work done by the author and his collaborators, and on published data. A particular feature of the article is its element-by-element approach to the problems concerning the extraction chemistry and the processes and apparatus of extraction technology. The basic steps of a complex extraction process are considered, and then the process as a whole. With this approach it is possible to elucidate the mechanism of such processes, discover the quantitative laws to which they are subject, and give a reasoned mathematical description of them. (141 references.) (auth)

396 EXTRACTION OF URANIUM FROM MONAZITE AFTER SEPARATION OF THORIUM AND RARE EARTHS. Hilal, O. M.; Kiwan, A. M. (National Research Center, Cairo). Indian J. Technol., 6: 17-19(Jan. 1968).

Recovery of U from waste monazite sulfate solution left after the separation of Th and rare earths was carried out by extracting it with a mixed solution of mono- and di-2-ethylhexylphosphoric acids in kerosene. The efficiency of extraction was greatly enhanced by reducing U prior to extraction. The efficiency of HCl, H_2SO_4, and H_3PO_4 in back extracting U(IV) from the extractant was also investigated. The back extraction of U was improved by oxidizing it during the stripping process. Uranium was finally precipitated by adding dilute NH_4OH solution after distilling most of the acid. On recycling the extractant, its extracting capacity fell from 98.3% in the first cycle to 88.6% in the sixth cycle. This gradual decrease was attributed to: (1) coextraction and building up of Ti(IV) in the extractant during recycling, for the extracted Ti(IV) behaves similar to U(IV) in having almost no tendency to be back extracted by HCl solution; and (2) extractant losses due to solubility and hydrolysis about 1 to 2% of the extractant was lost per cycle. (BBB)

397 SEPARATION OF CADMIUM FROM SILVER AND OTHER ELEMENTS BY ANION EXCHANGE CHROMATOGRAPHY IN HYDROBROMIC ACID AND PREPARATION OF CARRIER-

FREE ^{109}Cd FROM CYCLOTRON TARGETS. Strelow, F. W. E.; Louw, W. J.; Weinhert, C.H.-S. W. (National Chemical Research Lab., Pretoria). Anal. Chem., 40: 2021-4(Nov. 1968).

Silver is quantitatively separated from cadmium by elution with 6.7M HBr from a column of AG1-X8 anion exchange resin in the bromide form. Zn, In, Cu(II), Co(II), Ni(II), Mn(II), Fe(III), Ga, and U(VI) can be eluted with 0.2M HNO_3 containing 0.05M HBr. Cd is retained by the column and can be eluted with 3M HNO_3 or with 1M NH_4OH containing 0.1M NH_4NO_3 and 0.02M NH_4Br. Separations are sharp and quantitative for Cd:Ag ratios from 1000:1 to 1:30000 and above. The method was applied to the separation of carrier-free ^{109}Cd from several grams of cyclotron irradiated silver. Tables of distribution coefficients for Cd and Ag in HBr, NH_4Br, HI, and KI are presented together with elution curves and results of quantitative separations of synthetic mixtures. (auth)

398 CATION EXCHANGE SEPARATION OF THORIUM FROM RARE EARTHS AND OTHER ELEMENTS IN METHANOL-NITRIC ACID MEDIUM CONTAINING TRIOCTYLPHOSPHINE OXIDE. Korkisch, Johann; Orlandini, K. A. (Argonne National Lab., Ill.). Anal. Chem., 40: 1952-5(Nov. 1968).

The batch distribution coefficients of thorium, rare earths, and many other elements were determined on the strongly acidic cation exchanger Dowex 50 in mixed aqueous–organic solvent systems containing organic phosphorus compounds and nitric acid. These investigations showed that from some of these media, thorium is not retained on the resin while rare earths and numerous other metal ions are strongly adsorbed making possible their quantitative separation from thorium. The most suitable medium for the complete separation of tracer and milligram amounts of thorium is 0.1M trioctylphosphine oxide (TOPO) in methanol containing 5 vol % of 12M nitric acid. With this eluent, thorium is eluted ahead of rare earths and numerous other elements with separation factors in the order of $>10^2$ to 10^4. Less suitable systems were investigated in which methanol was replaced by acetone, tetrahydrofuran, acetic acid, and methyl glycol or media in which nitric acid was replaced by hydrochloric acid. If in place of TOPO other extractants such as bis(2-ethylhexyl)orthophosphoric acid (HDEHP) or tri-n-butylphosphate (TBP) are employed, thorium is less readily eluted from Dowex 50. The effectiveness of the organic extractants increased in the order TBP < HDEHP < TOPO. (auth)

399 FLOTATION OF LOW GRADE URANIUM ORE FROM BHATIN, BIHAR STATE. Viswanathan, K. V.; Somnay, J. Y. (Bhabha Atomic Research Center, Trombay, India). J. Mines Metals Fuels, 15: No. 1, 20-3(1967).

Flotation studies undertaken with the synthesized collectors at different pH conditions and different proportions of mono- and diesters have been described. It was found that a mixture of mono- and dioctyl phosphate in the ratio of 1:1 at a pH ~2 was very effective in flotation of uranite. (Indian Sci. Abstr.)

400 ON THE FORMATION OF URANIUM COMPOUNDS AND OF SOME ACCOMPANYING ELEMENTS IN FORMALDOXIME, BY PAPER ELECTROPHORESIS. I. SEPARATION OF UO_2^{2+} FROM Ce^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, AND Cu^{2+}. Marcu, Gheorghe; Botar, Alexandru. Stud. Univ. Babes-Bolyai, Ser. Chem., 13: No. 1, 111-15(1968). (In Rumanian).

The formation of the compounds of UO_2^{2+}, Ce^{3+}, Fe^{3+}, Co^{2+}, Ni^{2+}, and Cu^{2+} with formaldoxime was investigated by paper electrophoresis. It was established that in the 0.1 M solutions, ionic species with positive charge, probably of $[Me^{n}(CH_2NOH)_m]^{n+}$ type, are formed. In 1 M formaldoxime solutions at certain values of pH, in alkaline medium, there are formed ionic species with negative charge, probably of $[Me^{n}(CH_2NO^-)_6]^{n-6}$ type, which migrate towards the cathode. There were calculated the values of the electrophoretic mobilities on No. 1 Whatman paper, at a potential difference of ~1000 V and 20 mA, for 30 minutes. It was established that in these conditions, in 0.1 M solutions, uranium separates very well from Ce, Co, Ni, and Cu in the pH interval = 3.3 to 7.0 and from Fe at pH = 1.4 to 2.7. In 1 M solutions, uranium separates very well from Fe, Co, Ni, and it separates well from Cu at pH ~4.02 and from Ce at pH = ~9.50. (auth)

401 TRIS(n-OCTYL)ARSINE OXIDE (TOCASO) AS A REAGENT FOR LIQUID-LIQUID EXTRACTION. II. EXTRACTION OF IRON(III), ZINC(II), CADMIUM(II), HAFNIUM(IV), AND ZIRCONIUM(IV). Irgolic, Kurt; Zingaro, Ralph A.; Linder, Donald E. (Texas A and M Univ., College Station). J. Inorg. Nucl. Chem., 30: 1941-55(Aug. 1968). (ORO-2733-9).

The extraction of the metal ions Fe(III), Zr(II), Cd(II), Hf(IV), and Zr(IV) by tris(n-octyl)arsine oxide (TOCASO), in benzene, was investigated. The Fe(III), Zn(II), and Cd(II) halides were extracted from the hydrohalic acid solutions, while Hf(IV) and Zr(IV) were extracted from citric acid media. The extraction coefficients, E_a^0, for zinc and cadmium were found to increase with increasing pH. E_a^0(Zn) reached a limiting value of ~1750 in pH range 4.5 to 6.8, while E_a^0(Cd) was found to reach a limiting value of ~63 in pH range 2.7 to 7.2. Iron(III) was readily extracted at pH values ≥0. The extraction coefficient for hafnium(IV) reached a maximum of 200 at pH 2.7 and decreased steeply on either side of this maximum, while E_a^0[Zr(IV)] reached a maximum value of 140 at pH 4. First power dependence on the reagent concentration was observed for the extraction of Fe(III), Hf(IV) and Zr(IV) from aqueous chloride solutions and for CdI_2 at low TOCASO concentrations. Second power dependence on the reagent concentration was observed for the extraction of the zinc(II) halides and cadmium(II) iodide at higher TOCASO concentrations, while $E_a^0(CdCl_2)$ and $E_a^0(CdBr_2)$ showed a third power reagent dependence. Infra-red spectra of the products isolated from the equilibration of the metal salts with TOCASO were measured, and the arsenic-oxygen, metal-oxygen, and metal-halide stretching frequencies. (auth) (UK)

402 ANALYTICAL CHEMISTRY OF PROTACTINIUM. COMMUNICATION 1. PRECIPITATION OF PROTACTINIUM WITH PHENYLARSONIC ACID. Myasoedov, B. F.; Pal'shin, E. S.; Molochnikova, N. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 23: 1491-7(Oct. 1968). (In Russian).

A study has been made of protactinium precipitation with phenylarsonic acid (PAA). It has been shown that protactinium is precipitated by this reagent practically quantitatively from solutions of sulfuric, hydrochloric, and nitric acids at the acid concentration of 7 N or less. It has been shown by a thermogravimetric study of a protactinium-PAA compound that protactinium phenylarsonate separated from strongly acid solutions and dried at 120 to 180°C has the composition of $H_3PaO_3(C_6H_5AsO_3)_2$ (or close to this). This compound can be used as a weight unit (the conversion factor for protactinium is 0.346). The possibility has been studied of using PAA for the separation of protactinium from other elements. On the precipitation of protactinium with PAA from solutions 5 N with respect to H_2SO_4 and 0.1 M with respect to $H_2C_2O_4$ protactinium can be readily separated from large as well trace amounts of iron, zirconium, and niobium. (auth)

403 EXTRACTION SEPARATION OF PLUTONIUM BY MEANS OF 1-PHENYL-3-METHYL-4-BENZOYLPYRAZOLONE-5. Chmutova, M. K.; Palei, P. N.; Zolotov, Yu. A. Zh. Anal. Khim., 23: 1476-80(Oct. 1968). (In Russian).

Extraction of uranium(VI), neptunium(V), americium(III), plutonium(VI), plutonium(III), zirconium, niobium, and fission products by means of 1-phenyl-3-methyl-4-benzoylpyrazolone-5 solutions in benzene has been studied. The extraction of zirconium has been studied in detail. Using the data obtained and published before on plutonium(IV) extraction the possibility was found for separating plutonium from uranium and americium, as well as from uranium and the fission products. (auth)

404 ISOLATION OF RADIOCESIUM FROM A FISSION PRODUCT MIXTURE. Krtil, J. (Nuclear Research Inst., Rez, Czechoslovakia). J. Radioanal. Chem., 1: 201-9(May 1968).

A method of ^{137}Cs isolation from strongly acidic solutions of fission products is described, in which vanadyl ferrocyanide is used as a selective ion exchanger for cesium. The effects of the acidity of medium and the carrier concentration on the quantitative yield of separation were studied and convenient conditions were found for ^{137}Cs isolation from the solution of fission products formed after irradiating uranium with neutrons. (auth)

405 RAPID RADIOCHEMICAL SEPARATIONS. IV. SEPARATION OF RARE EARTH METALS BY ELUTION CHROMATOGRAPHY ON CATION EXCHANGE COLUMNS. Bleyl, H.-J.; Muenzel, H. (Kernforschungszentrums, Karlsruhe, Ger.). Radiochim. Acta, 9: 149-53(Aug. 1968). (In German).

A fast separation procedure for lanthanides by means of ion exchange columns was developed. The best values for the experimental conditions were determined with a simple optimalization-procedure. Under optimum conditions a separation of Pm from Nd and Pr as well as Sm from Pm and Nd is possible within 3 min giving a yield of 50% and a separation factor $\geq 10^3$. (auth)

406 THE SOLVENT EXTRACTION OF HAFNIUM(IV). VI. EXTRACTION OF Hf(IV) BY SOME DIALKYLPHOSPHORIC ACIDS FROM CHLORIDE AND NITRATE MEDIA. Navratil, O. (Faculty of Natural Sciences, Brno). J. Inorg. Nucl. Chem., 30: 1605-16(July 1968).

The distribution of $^{175+181}$Hf(IV) between aqueous hydrochloric or nitric acid and a solution of dibutylphosphoric acid in benzene and chloroform, di-n-amylphosphoric acid in toluene, and diethylhexyl-and di-n-octylphosphoric acids in n-octane was studied. In the range of concentrations of Hf used (up to 2×10^{-6}M), Hf was extracted from a hydrochloric acid medium up to C_{HCl} 3.5 M pre-

dominantly as $HfClA_3(HA)_2$, where HA is the dialkylphosphoric acid. In a medium of nitric acid at $C_{HCO_3} \geq 1.5$ M, or hydrochloric acid at $C_{HCl} \geq 4.5$ M, the initial ion-exchange reaction mechanism was replaced by an addition type of reaction with the formation of extractable complexes of $HfX_4(HA)_y$, where X = NO_3, Cl. At higher concentrations of HNO_3, an extractable $HNO_3 \cdot HA$ complex was formed, which results in a decrease in the distribution ratio of Hf. (auth) (UK)

407 USE OF THERMAL DECOMPOSITION OF COMPOUNDS OF RARE EARTH ELEMENTS IN O_2 ATMOSPHERE FOR THEIR SEPARATION. Pajakoff, Sw. (Technische Hochschule, Vienna). Monatsh. Chem., 99: 1409-27(July-Aug. 1968). (In German).

The nitrates, carbonates, oxalates, citrates, succinates, malonates, and complexonates of Ce, Pr, and Tb decompose in an oxygen atmosphere at much lower temperatures (320 to 360°C) than the corresponding compounds of the remaining rare earths (500 to 550°C). A new separation method, based on a selective thermal decomposition, combined with a selective extraction of the reaction products with complex forming solutions was worked out. This method is proposed for the analysis and investigation of the cerite earths, and for the enrichment of U, Th, Sc, Y, and other radioactive substances. (auth)

408 HYDROGEN AND OXYGEN ISOTOPE FRACTIONATION BETWEEN ICE AND WATER. O'Neil, James R. (U. S. Geological Survey, Menlo Park, Calif.). J. Phys. Chem., 72: 3683-4(Oct. 1968).

In order to determine equilibrium fractionations for both deuterium and oxygen-18 in the freezing and melting of water, gases from ice and water samples were analyzed mass spectrometrically for isotopic content. Isotopic compositions and fractionation factors are tabulated. Possible sources of error due to experimental technique are considered. (J.G.B.)

409 ON THE POSSIBILITY OF SEPARATING THE ISOTOPES OF ELEMENTS OF MEDIUM AND HIGH MASS BY CHEMICAL EXCHANGE. Knyazev, D. A.; Ivlev, A. A.; Bantysh, A. N.; Dobizha, E. V. Kernenergie, 11: 229-38(Sept. 1968). (In German).

Based on the quantum statistical calculations of single-stage separation factors (α) and partition function ratios (β factors) by Urey, Mayer, and Bigeleisen, a γ value was calculated, which may be interpreted as an efficiency coefficient. In order to assess the practicability of an isotope exchange reaction, the thermodynamic and the kinetic behavior of the compounds in question has to be studied. A classification is introduced of isotope exchange systems in terms of valency, field strength of ligands, and coordination number, which are regarded as not interdependent, to come to conclusions on the γ values of the chemical systems. For illustration, examples of the various classes are given and explained. (auth)

410 DYNAMICS OF ESCAPING OF ACCUMULATED RADON ON HEATING ROCK. Pritchin, B. P. At. Energ. (USSR), 25: 324-5(Oct. 1968). (In Russian).

The rate of radon separation from rock was studied as a function of the temperature gradient (from 20 to 260°C) for carbonaceous silicon and carbonaceous-clay schists. (R.V.J.)

411 MILLING TECHNOLOGY OF URANIUM ORES. Ross, Alvin H.; Guglielmin, Leonard G. (A. H. Ross and Associates, Toronto). Nucl. Appl., 5: 311-18(Nov. 1968).

North American methods of uranium ore processing include leaching with either sulfuric acid or a soda ash–sodium bicarbonate mixture. From the acid leachings either solvent extraction or ion exchange extracts high-grade uranium, which is then precipitated with ammonia or magnesia. Finer grinding, higher temperatures, and sometimes high pressure are required with the alkaline leach, which yields sodium diuranate. Uranium mills can now be built with confidence in design and performance. The average capital cost for acid leach mills for 500 to 5,500 tons of ore per day varies from $7,550 to $3,350 per ton daily, respectively; alkaline leach mills cost 10% more. Direct milling costs range from $0.88 (New Mexico) to $1.53 (Elliot Lake, Canada) per pound of U_3O_8 recovered and are decreasing. Ore grade has little effect on recovery yield or on cost per ton milled but a marked effect on cost per pound of U_3O_8 recovered. Although prior demand was for yellow cake, the integration of mining, milling, and refining operations could eliminate the yellow cake precipitation step and save 7 to 11¢/lb U. Direct production of UF_4 is feasible, but ammonium diuranate is a good versatile product, and there is little economic advantage to feeding refineries with high-purity concentrates. (auth)

412 REMOVAL OF THE SODIUM BOND FROM SINTERED (U,Pu)C FUEL PELLETS. Litton, Felix B.; Bender, John H. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Nucl. Appl., 5: 299-301(Nov. 1968). (LA-DC-9448).

Low-temperature distillation is recommended as the method for removing sodium from sodium-bonded, sintered, mixed-carbide fuel pellets. Distillation of the sodium at 5×10^{-6} torr pressure and 485 ± 10°C has no deleterious effect on the microstructure, whereas the porosity may be altered by dissolution techniques. (auth)

413 PREPARATION OF PRECISELY DEFINED LITHIUM ISOTOPE MIXTURES. Pauwels, J.; Lauer, K. F.; Le Duigou, Y.; De Bievre, P. J.; Debus, G. H. (EURATOM, Geel, Belg.). Anal. Chim. Acta, 43: 211-20(Nov. 1968).

The need for accurate (<0.06%) isotopic blends of ^6Li and ^7Li is explained and their preparation is discussed. It is shown that lithium must be determined at an accuracy level better than 0.035%. Four methods, acid–base titration with hydrochloric acid or benzoic acid, and weighing as sulfate or carbonate, were tested and improved for the precise and accurate analysis of lithium hydroxide solutions. The results of these four methods for a 0.1 M solution agreed within ±0.02%. The preparation of pure isotopically enriched lithium hydroxide solutions, with specially purified cation- and anion-exchangers, is described. The prepared products contain as little as 100 μg of other metals and 50 μg of alkaline-earth metals per gram of lithium, and are sufficiently free of anions to permit accurate chemical assay of lithium. No changes in the isotopic compositions of 99% ^6Li or 99.99% ^7Li were detected during the treatment. (auth)

414 ENGINEERING FOR NUCLEAR FUEL REPROCESSING. Long, Justin T. New York, Gordon and Breach, 1967. 1031p. $56.00. (TID-24705).

This book surveys the field of engineering related to nuclear-fuel reprocessing. The book is made up of 14 chapters and 7 appendixes. Separate abstracts were prepared for each chapter. Numerous references are cited at the end of each chapter. (B.L.M.)

For abstracts of individual chapters see: 415–428.

415 INTRODUCTION. pp 1-25 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

This chapter serves to establish perspective for future chapters in the book by reviewing the pertinent features of nuclear reactors and by describing the relation between fuel reprocessing and the other parts of the nuclear fuel cycle. The trends in nuclear-fuel reprocessing and problems associated with nuclear-fuel reprocessing are briefly surveyed. (B.L.M.)

416 SPECIAL CONSIDERATIONS IN RADIOCHEMICAL PROCESSING. pp 27-159 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

A review is given of the laws governing the buildup and decay of radioactive nuclides as they influence the separations that must be made, the precautions to avoid criticality, the amount and kind of shielding necessary, the amount of heat that must be removed, and the composition of the radioactive wastes in reprocessing of nuclear fuels. The elements of radiation shielding are described, and the kinds of calculations that are made in shielding design are shown. A qualitative description of criticality is included to acquaint the engineer with the methods for preventing criticality and to give insight into the reasons for the restrictions imposed by criticality on plant design and operation. Some problems related to both preventive and corrective maintenance and remote-control equipment associated with maintenance are presented. Disposal and treatment of wastes as determined by the radioactive components are discussed. (113 references). (B.L.M.)

417 SEPARATIONS PROCESSES. pp 161-272 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

Solvent extraction, precipitation, and nonaqueous processes for separations in fuel reprocessing are discussed. Solvent extraction processes are treated in detail with special attention being given to theories of solvent extraction, to TBP as an extractant, to hexone as an extractant, and to some other less known extractants. Flow sheets for the major extraction processes and the pretreatment and tail-end processing associated with these processes are discussed. Fluoride-volatility, chloride-volatility, and pyrometallurgical processes are discussed briefly. (228 references). (B.L.M.)

418 SPENT-FUEL DISSOLUTION. pp 273-325 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

Dissolution processes and equipment for dissolving reactor

fuel elements by both complete dissolution of fuel and cladding and leaching of fuel from cladding are described. Aqueous dissolution of fuels containing U, Th, and Al in HNO_3, caustic, or caustic nitrate solutions is reviewed. Zirflex, modified Zirflex, and STR processes for aqueous dissolution of Zr- and Nb-containing fuels are described. Dissolution of stainless steel-containing fuels in both HNO_3 and H_2SO_4 is described. Aqueous dissolution of Mo-containing fuels and an electrolytic dissolver for spent fuels are discussed. Some nonaqueous dissolution processes are discussed briefly. (105 references). (B.L.M.)

419 MECHANICAL OPERATIONS. pp 327-414 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The mechanical operations associated with the chemical processing of reactor fuel elements may be concerned with preparing the fuel elements, promoting the progress of the chemical step, or purifying the product. Many problems, such as sealing rotating shafts to ensure containment of radioactivity and lubricating bearings, are associated with these mechanical operations. Special problems are encountered in containing chips or dust resulting from sawing or chopping and in effecting substantially absolute separation of mists and smokes from gas streams. The solutions to some of these problems are delineated in this chapter. Separate discussions are presented for agitation, centrifugation, filtration of liquids, filtration of gaseous streams, gas-solid fluidization, and mechanical separation of fuel and jacket. (121 references). (B.L.M.)

420 FLUID FLOW. pp 415-68 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

Various aspects of fluid flow in radiochemical processing are reviewed. Discussions of piping and pipe connections, pumping methods and equipment, and valves are presented. The following special problems brought about by radioactivity are emphasized: necessity to minimize leakage, necessity for shielding, remote operation, and remote maintenance and replacement. (35 references). (B.L.M.)

421 HEAT-TRANSFER OPERATIONS. pp 469-536 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The transfer of heat in processes involving radioactive materials is treated with special emphasis on the unusual types of equipment or operation occasioned by the necessity of avoiding contamination with radioactivity. The kinds of heating and cooling met in radiochemical processing are described, and applications are discussed. Various types of equipment are discussed for boiling, evaporation, and condensation operations. The drying and calcining of solids are discussed in the area of denitration of $UO_2(NO_3)_2 \cdot 6H_2O$ to obtain UO_3 and calcination of aqueous waste from solvent-extraction processing to obtain stable solids. (84 references). (B.L.M.)

422 SOLVENT EXTRACTION. pp 537-632 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The advances in solvent-extraction equipment technology achieved through the study of its application to radiochemical processing are recorded. The specialized contactors developed for radiochemical processing are described at length and some are illustrated. The significance of the various design and operating variables and their interrelations is presented in detail for pulse columns, compact-box mixer-settlers, and centrifugal contactors. Other types of solvent-extraction equipment are briefly discussed. (114 references). (B.L.M.)

423 OTHER MASS-TRANSFER OPERATIONS. pp 633-726 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

Mass-transfer operations other than solvent extraction that are of importance in nuclear-fuel reprocessing are reviewed. Discussions are presented for distillation, absorption, adsorption, ion exchange, and foam separations. Emphasis is given to unique aspects of the particular application and to the equipment necessary for use in radiochemical processing. (125 references). (B.L.M.)

424 INSTRUMENTATION. pp 727-85 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The design aspects of instrumentation for a radiochemical processing plant are discussed in detail. Three types of instruments are discussed; instruments for process information, instruments for continuous analytical operations, and instruments for radiation protection. The advantages and disadvantages of certain type instruments and the difficulties introduced by the remote operation aspects of radiochemical processing are emphasized. (56 references). (B.L.M.)

425 AUXILIARY EQUIPMENT. pp 787-858 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

Some equipment, important not for its use directly in fuel reprocessing but in carrying out auxiliary operations, is described. Methods for viewing remote operations, carrying out manipulative procedures, transporting radioactive materials, and sampling radioactive process streams are discussed in detail. The design of special shielded cells with requirements for entry and exit, viewing, manipulating, ventilation, and confinement is discussed. (66 references). (B.L.M.)

426 RADIOCHEMICAL PLANT DESIGN. pp 859-903 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The design of a plant for the chemical processing of spent nuclear fuels involves certain characteristics arising from the necessity of remote operations and the importance of radiation safety. The unusual design features that result from the presence of radioactivity and potential criticality are discussed as they affect the design of the reprocessing method, plant location, plant layout, and details of material selection and equipment design. (57 references). (B.L.M.)

427 PLANT MANAGEMENT AND OPERATION. pp 905-23 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

The facets of plant operation peculiar to radiochemical processing are described and attention is called to special aspects of ordinary plant functions that must be considered in operating such a plant. Special attention is given to the complications introduced by the radioactive nature of the process materials and to the extensive government regulations necessary for their control. Discussions of both plant startup and re-work procedures are included as well as routine plant operation. (B.L.M.)

428 RADIOCHEMICAL-PROCESSING COSTS. pp 925-52 of Engineering for Nuclear Fuel Reprocessing. Long, Justin T. New York, Gordon and Breach, 1967.

This discussion of economics of fuel reprocessing is limited to aqueous reprocessing in which the fuel is essentially decontaminated. The costs of capital investment, which includes buildings, vessels, piping, instrumentation and waste treatment and of operation, which includes overall plant operation, radiochemical analyses, and hot-cell service operation, are all discussed. The unique characteristics of radiation and fission are the cause of the high capital and operating costs. (B.L.M.)

429 CHEMICAL AND ELECTROLYTICAL DECONTAMINATION OF LEAD CONTAMINATED BY VARIOUS RADIOACTIVE ISOTOPES. Miazek-Kula, M. Pr. Cent. Inst. Ochrony Pracy, 18: 239-50(1968). (In Polish).

Experiments for decontaminating lead contaminated by ^{60}Co, ^{65}Zn, ^{90}Sr, ^{106}Ru, ^{124}Sb, ^{131}I, ^{137}Cs, and ^{204}Tl by chemical and electrochemical methods are described. Two groups of decontaminating media by means of which a high degree of lead decontamination can be obtained are specified. These media are: strongly corroding fluids such a solution of 7 parts of glacial acetic acid + 3 parts H_2O_2 (some 29%) and 1 to 4 N HNO_3; and feebly corroding fluids such as 0.2 N HNO_3, 5% acetic acid, and 5% sodium citrate. The time required for a high degree of decontamination was short (1 to 10 min) for all isotopes when strongly corroding media were applied. However, for feebly corroding fluids this time varied depending on the kind of isotope involved. For the electrolytic method the application of anodic decontamination in some 0.2 N HNO_3 with a current density of about 50 mA/cm^2 for 1 to 4 min was indicated as the most favorable solution. (auth)

430 INITIATION OF INTERFACIAL TURBULENCE IN LIQUID–LIQUID SYSTEMS. Skinner, Richard Donald. Stillwater, Okla., Oklahoma State Univ., 1967. 135p.

Thesis.

A modification of the flowing junction type diffusion cell and a birefringent interferometer were developed for the study of interfacial turbulence in immiscible liquid-liquid systems. A study was made to evaluate the causes of interfacial turbulence when uranyl nitrate is transferred from an aqueous phase into an organic phase (30% TBP and 70% n-heptane). An interfacial turbulence system of toluene–acetone–water was used during the development of the cell and the experimental procedure for this study. With the modified cell, a step change in solute concentration was generated along a parabolic shaped immiscible liquid-liquid interface. The magnitude of the step change was varied in order to determine the minimum step change required to produce

interfacial turbulence for each system studied. All of the systems tested experienced interfacial turbulence when the step change in interfacial tension along the immiscible liquid-liquid interface was greater than 1 dyne/cm. From an evaluation of the disturbance factors and the ratio of solute diffusivity in the aqueous phase to the solute diffusivity in the organic phase, all of the TBP–n-heptane–uranyl nitrate–water systems tested were found to have a potential for instability of the stationary type. However, interfacial turbulence was experimentally observed only in those systems where the step change in uranyl nitrate concentration across the interface was sufficiently large. (Disser. Abstr.)

431 EXTRACTION OF THORIUM FROM NITRIC ACID SOLUTIONS BY LONG-CHAIN ALIPHATIC AMINES. Sato, Taichi (Shizuoka Univ., Hamamatsu, Japan). Anal. Chim. Acta, 43: 303-10(Nov. 1968).

The partition of thorium between nitric acid solutions and solutions of long-chain aliphatic amines in benzene is described. The organic phase was examined by infrared spectroscopy. Tertiary amines are more efficient extractants for thorium than are secondary amines; the efficiency is enhanced when the alkyl chain is branched and is strongly influenced by the organic solvent used as diluent. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 496, 650, and 673.

432 (AD-670010) FALLOUT SIMULANT DEVELOPMENT: TEMPERATURE EFFECTS ON THE SORPTION REACTIONS OF STRONTIUM ON FELDSPAR, CLAY, AND QUARTZ. Lane, William B. (Stanford Research Inst., Menlo Park, Calif.). Aug. 1967. Contract N00228-67-C-2037. 48p. CFSTI.

Procedures were developed for the preparation of synthetic fallout with which to study the availability of strontium. Mineral particles were tagged with ^{85}Sr and heated to a series of temperatures including 1500°C. The effect of these thermal treatments on the availability of strontium was evaluated by leaching in 0.1N HCl. Surface adsorption effects were measured on particles that were not heated. The reproducibility of the results obtained by those procedures was tested by preparing batches of synthetic fallout with specified properties for other OCD studies. (auth) (USGRDR)

433 (AEC-tr-6977) EXPERIMENTAL STUDY OF THE WATER CONTENT MEASUREMENTS OF SOIL USING INTERMEDIATE NEUTRON TRANSMISSION. Wack, Bernard. Translated by J. C. Corey (Savannah River Lab., Aiken, S. C.), from Compt. Rend., Ser. A and B, 264: 1098-1101(1967). 5p. Dep. CFSTI.

An experimental method utilizing intermediate neutron transmission for the measurement of the water content of soil thicker than 10 cm is described. Different measurement and detection geometries have been tested. The results have been compared mathematically with a standard curve. In all cases the quadratic mean error is less than 2.1% of the actual moisture value. (auth)

434 (GAT-574) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, FIRST HALF 1968. Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). Aug. 19, 1968. Contract AT(33-2)-1. 11p. Dep. CFSTI.

The average environmental radiation and concentration levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the first half of 1968 and for the calendar year 1967, are summarized. For the first half of 1968 the water beta-gamma, air alpha and beta-gamma, and the background dose rate remained substantially unchanged compared with the 1967 results. The water alpha increased slightly for the first half of 1968. However, the overall results for alpha in water equaled only 0.13 percent of the AEC Concentration Standards. Penetrating background dose rates remained unchanged from the first half 1967 values. In the calculations all of the exposure rates were assumed attributable to plant operations. As in the past, however, the off-site and on-site patterns are very much alike in form and intensity with no significant difference between average values. Based on the on-site and off-site intensities, it is evident that the plant operations have not added appreciably to the general background penetrating radiation. (auth)

435 (IA-1127) MOBILE RADIOACTIVE TRACER LABORATORY FOR HYDROLOGICAL STUDIES. Schwarz, J.; Hefetz, E.; Bachar, R.; Franz, J.; Surkes, M. (Israel Atomic Energy Commission, Tel Aviv). June 1968. 42p. Dep.

A mobile laboratory for labeling water with radioactive tracers is described. The construction of the laboratory, the devised isotope injection system, working procedures, health physics aspects and equipment are given. The advantages of the mobile laboratory compared with previous set-ups for radioisotope injection into water streams are outlined. (auth)

436 (NSJ-tr-123) APPLICATION OF RADIOISOTOPE TO PROSPECTING FOR MATSUIWA. Inoue, Masayasu; Omi, Mitito. Translated from Kumamoto Daigaku Kogakubu Kenkyu Hokoku, 14: No. 2, 64-70(Nov. 1965). 15p. Dep.

A series of experiments was performed on the detection of Matsuiwa, which presents a problem in the rationalization of coal mine operation and in increasing mining efficiency. Experiments which were carried out on the attenuation of γ-rays when Matsuiwa was existent or non-existent in the coal are described. The experiments were conducted both in the laboratory and in the actual coal mine using ^{60}Co as the radiation source. Matsuiwa is a very hard rock of SiO_2, produced in spaces left by rotted plants in the coal bed. The results obtained are as follows: in detection of Matsuiwa, when the coal-bed source concerned is not smooth, it is desirable to place both the radiation source and the detector in the respective holes, which are cut at regular intervals, perpendicular to the coal-bed surface and parallel to each other; the ^{60}Co source intensity is about 100 mCi; and when 100 mCi of ^{60}Co are used with any ordinary scintillation counter at regular intervals of up to 2 m from the source to the detector, the effects of the presence of Matsuiwa most remarkably appears, leading to its easy detection. (auth)

437 SIMULATION OF THE HYDROLOGIC TRANSPORT OF RADIOACTIVE AEROSOLS. Huff, Dale Duane. Stanford, Calif., Stanford Univ., 1968. 215p.

Thesis.

A mathematical model, programmed in PL/1 computer language, was constructed as a tool for evaluating the relative importance of factors affecting radioaerosol transport through a watershed. The model is useful for studying the processes affecting the hydrologic transport of ^{90}Sr and ^{137}Cs radioaerosols deposited by fallout. This model, the Hydrologic Transport Model (HTM), includes the effects of deposition, vegetal interception, land surface interactions, and channel transmission on discharge of radioaerosols in streamflow. The HTM is based on relating runoff processes to radioaerosol transport. A continuous estimate of the water budget for a selected watershed is maintained by the Stanford Watershed Model, which was altered for this study to include the HTM equations. The water budget was used to simulate radioaerosol discharge from a basin through consideration of the combined influences of runoff, ion exchange reactions, and erosion. A field study was conducted to aid in the construction and evaluation of the HTM. It included experimental determination of ^{90}Sr and ^{137}Cs radioaerosol deposition, spatial distribution, ion exchange properties, and discharge from a selected watershed. Solution of the model equations was accomplished with an IBM 360/67 computer. Results of radioaerosol discharge simulation from the Saratoga Creek, California watershed are presented together with corresponding observed values for three storms. Recorded and simulated streamflow are also presented to illustrate the accuracy of the moisture budget for the storms investigated. Other experimental results for ^{90}Sr and ^{137}Cs radioaerosols, included as input parameters to the HTM, are: monthly and hourly deposition, spatial distribution in the watershed, and ion exchange distribution coefficients. The HTM should serve as a useful tool for indicating the relative importance of the complex physical processes which affect transport. It is apparent from experimental observations that erosion and the transmission of sediment load are the major factors influencing ^{90}Sr and ^{137}Cs transport. Thus, the continued investigation of radioaerosol transport should lead to some valuable insight into these complex processes. (Disser. Abstr.)

438 TRANSPORT OF ^{85}Sr AND ^{137}Cs UNDER INDUCED CLAY SUSPENSIONS. Purushothaman, Krishnier. Austin, Tex., Univ. of Texas, 1968. 142p.

Thesis.

The effects of induced clay suspensions on the transport of ^{85}Sr and ^{137}Cs in an aqueous environment were studied. An instrumented flume was used as a model river to simulate an environment typical of a slow-moving, unpolluted, turbid stream. Modified longitudinal dispersion relationships were used to describe the transport of radionuclides in turbid streams. Data were derived from instantaneous release of ^{85}Sr and ^{137}Cs with suspended Attapulgite and Kaolinite clays. Continuous release of ^{137}Cs with an Attapulgite clay suspension helped to establish uptake and transport characteristics for one environmental condition. Aquaria and laboratory studies preceded the model river experiments to define more specifically some of the physical and chemical characteristics. Suspended clay in the model river system produced a significant reduction in the transport of ^{137}Cs. Conversely, the transport of ^{85}Sr was not affected appreciably since most of the ^{85}Sr remained in solution. (Disser. Abstr.)

439 8th CONGRESS OF THE INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS. TOPICS INCLUDE USE OF ISOTOPES IN GROUNDWATER STUDIES, ISTANBUL, TURKEY, SEPTEMBER 10-22, 1967. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 1-585(1967). (CONF-670972).

Eighty-two papers were presented at the 8th Congress of the International Association of Hydrogeologists held in Istanbul in 1967. Separate abstracts were prepared for 6 papers. The remaining 76 papers on hydrogeological investigations were not within the scope of NSA. (L.C.L.)

For abstracts of individual papers see: 445–450.

440 APPLICATION OF ISOTOPE TECHNIQUES IN GROUNDWATER HYDROLOGY. Csallany, Sandor C. (Illinois State Water Survey, Urbana). pp 351-7 of Proceedings of the Symposium on Groundwater Hydrology, San Francisco, Califor-

nia, November 6, 7, and 8, 1967. Marino, Miguel A. (ed.), Urbana, Ill., American Water Resources Association, 1967.
See CONF-671129.

A summary is presented of some current and possible future uses of radioisotopes in ground water research. The most commonly used radioisotopes and the methods in which they are used are tabulated. (L.C.L.)

441 STRATIFICATION OF RADIOISOTOPIC EFFLUENT IN A LAKE. Dimitroulas, Ch. (Democritos Nuclear Research Center, Athens); Papadimitropoulos, T.; Papakis, N. pp 341-9 of Proceedings of the Symposium on Groundwater Hydrology, San Francisco, California, November 6, 7, and 8, 1967. Marino, Miguel A. (ed.). Urbana, Ill., American Water Resources Association, 1967.
See CONF-671129.

An experimental investigation was performed to determine whether radioactive tracers could be used to measure water leakages through high infiltration areas at the bottom of a lake. Bromine-82 in the form of $^{82}BrNH_4$ solution was injected in approximately 0.5 Ci amounts at various water depths and radioactivity measurements were made by four portable scintillation counters mounted on small boats. From these measurements the dilution of the effluent from the injection point was calculated, and isoactivity curves for a specified depth of injection and a specified distance from the injection point were plotted. During the experiment no disturbance of the stratified tracer water was observed. Therefore, this method was concluded to be of little use in determining water leakages through high infiltration areas at the bottom of the lake. (L.C.L.)

442 TRANSPORT OF RUTHENIUM AND SODIUM THROUGH A SIMULATED AQUIFER. Champlin, Jerry B. F. (Georgia Inst. of Tech., Atlanta). pp 329-40 of Proceedings of the Symposium on Groundwater Hydrology, San Francisco, California, November 6, 7, and 8, 1967. Marino, Miguel A. (ed.). Urbana, Ill., American Water Resources Association, 1967.
See CONF-671129.

Two chemically diverse elements, sodium and ruthenium, were used to investigate the mechanism of ion transport through a model aquifer. A large box containing 1600 pounds of sand was constructed with permeable end-plates to permit horizontal flow. A radioactive solution containing ^{103}Ru was passed into the packed sand bed and the movement of the activity through the sand was observed by use of a Geiger–Mueller probe from the outside. Collection of the effluent showed a small portion of the total radioactivity had actually penetrated the sand bed with the water front. A significant portion of the effluent radioactivity was found associated with suspended fine particulate matter sufficiently large to be trapped on 0.45 micron membrane filters. Its radioactivity was determined and compared with the total received in the effluent. A similar procedure, using ^{24}Na as a tracer ion, led to the conclusion that some fine particulates in the sand bed exchanged ions with the solution and were sufficiently mobile in suspension to travel through the bed with the water into the effluent. This mechanism of ion transport appears to have much in common with the manner of migration of ions, such as ruthenium, observed in the field. The physical nature of these particles is considered and a discussion of the potential of using tagged particulates for water flow studies is included. (auth)

443 AQUIFER EVALUATION WITH RADIOISOTOPE WELL LOGS. Keys, W. Scott (Geological Survey, Denver). pp 319-28 of Proceedings of the Symposium on Groundwater Hydrology, San Francisco, California, November 6, 7, and 8, 1967. Marino, Miguel A. (ed.). Urbana, Ill., American Water Resources Association, 1967.
See CONF-671129.

A research project on borehole geophysics as applied to geohydrology is described. The equipment and methods used are discussed. Radioisotope logging is emphasized because it is the only presently available technique for obtaining information from cased holes. The radiation logs used included natural gamma, gamma-gamma, neutron-gamma, neutron-epithermal neutron, and radioactive tracer. These logs can provide information on the following: the source, chemical and physical character, velocity, and direction of movement of water; the location, character, continuity, geometry, bulk density, porosity, permeability, and specific yield of aquifiers and confining bed; the percent moisture in the unsaturated zone; and the position of casing, collars, leaks, perforations, and cement. Graphic data obtained by the various methods are presented and compared with each other and with laboratory data. Recommendations are made for further developing the potential of radiation logging techniques for use in ground water hydrology. (L.C.L.)

444 PROCEEDINGS OF THE SYMPOSIUM ON GROUNDWATER HYDROLOGY, SAN FRANCISCO, CALIFORNIA, NOVEMBER 6, 7, AND 8, 1967. Marino, Miguel A. (ed.). Proceeding Series No. 4. Urbana, Ill., American Water Resources Association, 1967. 365p. $7.00. (CONF-671129).

Thirty papers on ground water hydrology were presented at the conference. A separate abstract was prepared for each of four papers. One paper appeared previously in NSA as BNWL-SA-1586 (see 22: 21197). Twenty-five papers are not in scope for NSA. (L.C.L.)

For abstracts of individual papers see: 440–443.

445 MIGRATION OF RADIO ELEMENTS IN THE SOIL. Grison, G. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 392-414(1967). (In French).
From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

A brief review is presented of the studies of various factors affecting the transport, distribution, and dispersion of radionuclides in the soil. The solubility of the waste material, physico-climatic, and biological properties of the environmental media are discussed. Tabulated data are included in the comparisons of various methods of detection based on chemisorption, exchange, and fluid sample gaging calibration. (R.V.J.)

446 LABORATORY STUDIES OF FOUR TRACERS, ^{151}Cr EDTA–^{59}Fe EDTA–^{45}Ca EDTA–$(CN)_2$ ^{110}Ag. COMPARISONS OF THE RESULTS. Lallemand, A.; Grison, G. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 383-91(1967). (In French).
From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

Tracer properties of various isotopes used for labeling argilliferous (clay) and arenaceous (sandy) rocks of known characteristics were compared. Data obtained showed that ^{51}CrEDTA exhibited the best results. The isotope ^{110}Ag showed best results with the clays. Interesting results were also obtained with ^{59}Fe, while ^{45}CaEDTA proved to be ineffective as a tracer. (tr-auth)

447 DETERMINATION OF THE UNDERGROUND WATER-FLOW RATE IN A BOREHOLE IN THE KARST BY MEANS OF THE RADIOACTIVE METHOD. Kubelka, V.; Strohal, P. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 294-7(1967).
From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

A new method for underground water flow rate determination was developed. The method is based on the exponentional law of radioisotope dilution into the borehole. For this reason iodine-131 tracer was introduced into the borehole, mixed well in order to obtain a homogeneous concentration, and then the decrease of radioactivity was followed by an especially constructed probe. The experiments were performed in a laboratory scale and then in the Karst area. The agreement between both groups of experiments was satisfactory. In both cases a straight line was obtained when log activities versus time were plotted. The results indicated that the underground water flow rate could be determined knowing only the volume of borehole containing water and measuring the decrease of activity in the borehole. This method seems to be economical, fast, and therefore is very suitable for practical hydrogeological measurements. It is of special importance in the Karst where occur many fissures and crushing and therefore homogeneous porosity rarely exists. The method can be successfully applied in large scale of deepnesses. (auth)

448 DETERMINATION OF LEAKAGES FROM A LARGE WATER RESERVOIR USING RADIOISOTOPIC CURRENT METER. Dimitroulas, Ch.; Papadimitropoulos, T.; Papakis, N. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 287-93(1967).
From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

A technique is described by which losses from water reservoirs at great depths are determined. A device was constructed using three underwater scintillation detectors located on a vertical triangle and an injection reservoir containing radioactive NH_4 ^{82}Br among them. The three scintillators can be adjusted at a distance from the injection reservoir ranging from 5 to 50 cm according to the velocities of underwater currents to be measured. The signal of the underwater scintillators is registered by chart recorders located on board. The two scintillators detect very slow horizontal underwater currents and the other the vertical ones. Using this device to follow the horizontal currents from different directions, the infiltration area was located by the concentric convergence of all currents. After the location of the infiltration area, the vertical currents are measured and approximate amount of water which is lost is determined by the velocity of the vertical currents and the infiltration area. Underwater current velocities from 0.1 to 15 cm sec were measured and the total water losses in various lo-

cations were calculated. This method can be used safely even for drinking water supplies, because the amount of radioactive material used does not present any problem to the public health. (auth)

449 SOME CONSIDERATIONS ON TRITIUM DATING AND THE ESTIMATES OF TRITIUM INPUT FUNCTION. Dincer, T.; Davis, G. H. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 276-86(1967).

From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

Tritium has been used during recent years to estimate the transit and residence time of water in the hydrologic cycle. Explanations are given of the methods by which tritium is produced, the principle of tritium dating, and uses of the tritium method in hydrology. Even considering the complexity of determining tritium input due to tritium production by both natural and thermonuclear explosions, it appears that the tritium input to ground water can be accurately determined in many areas, especially when there is some record of the tritium content of the precipitation. It is concluded that the tritium method is complicated and requires careful sampling, analysis, and interpretation, but that it can yield valuable information on ground water transit and residence time as well as helping to estimate soil characteristics such as permeability and the hydrodynamic dispersion coefficient. (L.C.L.)

450 FIELD DETERMINATION OF SOIL PERMEABILITY BY THE NUCLEAR METHODS. Gaspar, E.; Oncescu, M.; Bisir, D. Mem., Ass. Int. Hydrogeol., Reunion Istanbul, 8: 267-75(1967).

From 8th Congress of the International Association of Hydrogeologists, Istanbul, Turkey. See CONF-670972.

Studies were undertaken in Roumania in 1965 and 1966 to prove the efficiency of radiometric methods for field determinations of soil permeability and to compare data simultaneously obtained by classical and new methods. Soil permeabilities in saturated soils determined by the point-dilution method, using ^{82}Br and ^{131}I as tracers, were comparable to those determined by pumping. Ground water flow through unsaturated soils measured by conventional and radiometric means also gave comparable results. It is concluded that radiometric methods offer an accurate, easy, and economical means of determining both soil permeability and ground flow measurements. (L.C.L.)

451 RADIOACTIVE AND RADIOGENIC ISOTOPE RESEARCH IN NORTH AMERICA. Doe, Bruce R.; Marvin, Richard F. Trans. Amer. Geophys. Union, 48: 672-86(1967).

Information on age estimation of rocks as well as an extensive bibliography on radioactive and radiogenic isotope research in North America is presented. The principles of geochronology and effects of geologic events on the isotopes used to determine ages are discussed. The trend in geochemistry is toward closely integrated and increasingly more detailed laboratory and field studies involving numbers of samples and several dating methods. The technical emphasis has been on whole rock Rb–Sr dating. The source of basalts and silicic rocks has been sought by measuring their Sr and Pb isotopes; it appears that the upper mantle is not uniform in terms of Sr and Pb isotopic composition. Discovery of $^{234}U/^{238}U$ inequilibrium in the incipiently weathered zone of a granite provides an excellent tracer in the weathering zone most difficult to recognize. (Geophys. Abstr.)

452 STABLE ISOTOPES. Taylor, Hugh P. Jr. Trans. Amer. Geophys. Union, 48: 686-93(1967).

Research on stable isotope geochemistry published from 1963 to 66 by scientists in the United States is discussed. Most results were obtained on isotopes of the light elements, mainly H, C, O, and S. Work on geothermometry, meteorites and tektites, igneous, and metamorphic rocks, sedimentary rocks, natural waters, and ore deposits is reviewed. A bibliography of pertinent works is given. (Geophys. Abstr.)

453 VERTICAL DISTRIBUTION OF FRAGMENT ELEMENTS IN SOME TYPES OF SOILS IN THE USSR. Brendakov, V. F.; Dibtseva, A. V.; Svishcheva, V. I.; Churkin, V. N. At. Energ. (USSR), 25: 331-2(Oct. 1968). (In Russian).

Vertical distribution of debris elements in USSR soils was studied in various landscape regions in order to determine isotopic penetration into the soil surface. The mean laboratory errors in determining radioactive isotopes are 5 to 10% for ^{137}Cs, 10 to 20% for ^{144}Ce and ^{106}Ru, and 20 to 30% for ^{125}Sb. Tabulated studies of the vertical distribution profile of total β activity in soils in southern districts showed a rapid decrease of fragments in depth in dense red earths which are represented by argillaceous soils enriched with iron oxides. A maximum penetration of isotopes was observed in brown soils. Data on vertical distribution of isotopes on a mountainside measured in the Far East during 1964 showed the main concentration at 3 cm depth (with ^{90}Sr-95%, ^{144}Ce-96%, ^{137}Cs-96%, ^{106}Ru-90%, and ^{125}Sb-90%). Studies of soils at depths below 33 mm revealed the presence of about 1% ^{90}Sr and rapidly disappearing while other isotopes were not found at such depths. (R.V.J.)

Meteorology

Refer also to abstracts 434 and 816.

454 (AD–670480) ANGULAR RADIATION CHARACTERISTICS OF ROUGH SURFACES CONTAMINATED WITH FALLOUT SIMULANT. Shumway, Bruce W.; Frank, Allen L. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 29, 1968. 50p. (USNRDL–TR–68–37). CFSTI.

The unscattered radiation from rough surfaces was measured using a NaI (T) spectrometer. The surfaces were prepared from rocks of graded size and for different spacings between the rocks. Some surfaces were dry and some sticky. Both perpendicular incidence of the contaminant upon the surface and oblique incidence were studied. The effects of thin aluminum sheets overlying activity on a flat smooth surface were also studied. In all cases the reduction in intensity of the primary radiation was measured as a function of angle relative to the normal to the surface. Whether or not a surface was sticky and, if sticky, the angle of incidence of the contaminant upon the surface affected the angular intensity of the radiation markedly. For one sticky surface the activity deposition was studied in detail. The findings together with the angular intensity measurements suggested a new mathematical model to represent sticky surfaces. (auth) (USGRDR)

455 (ANL–7360, pp 149-84) METEOROLOGICAL STUDIES. (Argonne National Lab., Ill.).

Data are presented on dewpoint temperature inversions. Instrumentation and available data on the climatography of vertical dewpoint profiles are reviewed. Climatological features of dewpoint inversions are discussed, e.g., frequency of dewpoint inversions and diurnal variation of dewpoint temperatures. The relation between the vertical dewpoint profile and associated meteorological variables is summarized. Modifications made to cup anemometer design to improve the measurement of mean horizontal wind speeds in turbulence are discussed. Instrumentation for atmospheric turbulence studies is described. A schematic representation of a fast response system for the measurement of temperature fluctuations in the inertial subrange is presented. Stack design parameters that influence plume rise are outlined. The effects of meteorological conditions upon radiation doses due to inhalation following a maximum credible reactor accident are discussed. (R.C.K.)

456 (ANL/ES–CC–1) CITY OF CHICAGO AIR POLLUTION SYSTEM MODEL. Quarterly Progress Report No. 1, February 1968. Croke, E.; Carson, J.; Clark, F.; Kennedy, A.; Roberts, J. (Argonne National Lab., Ill.). 106p. Dep. CFSTI.

The program to develop a Chicago air pollution dispersion model is described. The prediction of the severity of air pollution incidents, development of economical and optimum air pollution abatement strategies and the minimizing of the severity of pollution incidents, and long range city and county planning are discussed. Hourly SO_2 emission data accumulation was started and a study of the micro-meteorology of Chicago was initiated. Atmospheric dispersion theory was studied. A computer program to process data on emission inventory and air quality records was begun. A cooperative program to refine and improve the St. Louis physical dispersion model was undertaken to provide an alternative resource in the event that the statistical approach should be infeasible. The economics of air pollution abatement was studied. (F.S.)

457 (BNL–12833) A SUMMARY OF THE RECOMMENDED GUIDE FOR THE PREDICTION OF THE DISPERSION OF AIRBORNE EFFLUENTS. Singer, Irving A.; Smith, Maynard E. (Brookhaven National Lab., Upton, N. Y.). Aug. 29, 1968. 24p. (CONF–681007–1). Dep. CFSTI.

From Symposium on Urban Climates, Brussels, Belgium.

A summary of a recommended guide that is useful in predicting the dispersion of airborne effluents is presented. The guide is intended as a first approximation of simple situations in uncomplicated terrain. Emphasis is on ordinary, continuous stack emissions. (F.S.)

458 (IITRI–578–P–32–5) SCAVENGING STUDY OF SNOW AND ICE CRYSTALS. Final Report, April 1, 1967–July 31, 1968. Sood, Sudesh K.; Jackson, Meryl R. (IIT Research Inst., Chicago, Ill.). Sept. 12, 1968. Contract AT(11-1)-578. 42p. Dep. CFSTI.

The experimental determination of the scavenging efficiency of simulated snow and ice crystals is described. Paper aerodynamic

equivalents of snowflakes have been determined and used throughout this research. The scavenged aerosol consisted of spores of B. subtilis of 1 μ diameter. For plates of a given material, scavenging efficiency has been found to increase inversely with the diameter of the circumscribed circle. Scavenging efficiency of platelets has been found to increase with electrical charge on platelets. It has also been observed that the ratio of the number of particles deposited on the edges to the total number of particles deposited on the plate remains constant, irrespective of the charge on platelet. This ratio, however, does depend on the perimeter to surface area ratio of platelets. (auth)

459 (N-68-15503) HIGH-ALTITUDE RADIATION MEASUREMENTS. Quarterly Progress Report, July 1-September 30, 1967. Bartman, Fred L. (Michigan Univ., Ann Arbor. High Altitude Engineering Lab.). Jan. 1968. Contract NASr-54(03). 22p. (NASA-CR-92529; QPR-19). CFSTI.

Laboratory testing of the interferometer, preparations for the next balloon flight, and work on laboratory measurements of CO_2 transmission are described. (auth)

460 (SC-M-68-522) CLIMATOLOGY OF TONOPAH TEST RANGE, 1967. Schaeffer, J. R. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 74p. Dep. CFSTI.

The climatology of the Tonopah Test Range is described by: climatic summaries of temperature, relative humidity, station pressure, precipitation, and surface winds during 1967; summaries of the same elements based on 7-year averages covering the years 1961 to 1967; and summaries of upper winds based on the years 1961 to 1967. (auth)

461 (VUF-1037) WEATHER AND SURFACE RADIATION PREDICTION ACTIVITIES FOR THE STERLING EVENT: PROJECT STERLING. Final Report. Armstrong, R. H.; Morrell, J. R. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Lab.). July 1968. 28p. Dep. CFSTI.

In support of the Project Sterling Technical and Safety Programs, the Air Resources Laboratory-Las Vegas, Las Vegas, Nevada, provided meteorological services which included the compilation of climatological summaries, a program of surface and upper-air meteorological observations, and the preparation of weather and radiation predictions. These services are described and weather and radiation chronologies, relevant to shot-day, are recounted. (auth)

462 RADIOCHEMICAL DETERMINATION OF ^{210}Pb CONCENTRATIONS IN GROUND LEVEL AIR IN INDIA. Joshi, L. U.; Mahadevan, T. N. (Bhabha Atomic Research Centre, Trombay, India). pp 519-23 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The radiochemical procedure used and the results obtained in measurement of the airborne levels of ^{210}Pb in Bombay from October 1961 to March 1965 and at Srinigar from 1962 to March 1965 are given. Measurements were carried out on air-filter samples. The samples were ashed at about 250°C, the ash along with 2 ml of lead carrier (15 mg Pb/ml) was digested in aqua regia, the dried sample was dissolved in 1.5M HCl and passed through the ion exchange column, Dowex-1 in chloride form. Lead was adsorbed on the column. The adsorbed lead was eluted with 8M HCl. It was purified and then precipitated as lead sulfate in which form it was counted. The annual variations of ^{210}Pb concentrations at the two stations were examined and compared. The values varied from 6 μμg/1000 m^3 to 45 μμc/1000 m^3 at Bombay. There was a clear seasonal increase in values during the winter months of December to January of each year. The minimum values were during the months of June to August of every year. At Srinigar similar variations were noted although they were less pronounced. The likely causes for these are meteorological factors such as shifts in wind directions, etc. (auth)

463 STUDY OF RADIOACTIVITY OF RAIN WATER. Uppal, H. L.; Tarlok, Singh (Irrigation and Power Research Inst., Amritsar, India). J. Inst. Eng. (India), Public Health Eng. Div., 47: No. 2, 54-9(1966).

Study of natural and artificial radioactivity of rain water samples collected at Amritsar during Mar. to Aug. 1965 is presented. The beta activity was established with a high efficiency cylindrical type Geiger-Mueller (GM) detector and identification of isotopes made with a γ-ray spectrometer. The samples taken in July were more active than those collected in other months, which has been attributed partly to a delayed rainfall in that month and partly due to the Chinese atomic test in May 1965. Radioisotopes ^{231}Pa, ^{227}Th, ^{207}Tl, and ^{223}Ra were identified in the July samples. However, the amount of radioactivity was within the maximum permissible concentration and thus, the atmosphere did not offer any health hazard. (Indian Sci. Abstr.)

464 ^{65}Zn IN GROUND-LEVEL AIR AFTER THE 1967 CHINESE NUCLEAR TESTS. Kolb, W. (Phys-Tech. Bondesanstalt, Brunswick). Nature (London), 220: 364(Oct. 26, 1968).

Procedures used for determining radionuclides in ground-level air are described. Since the beginning of 1968 an additional peak at 1.12 MeV has been observed in the spectrum of the Mn fraction, apparently belonging to ^{65}Zn, and confirmed by chemical analysis. Possible reactions in bomb tests are $^{64}Zn(n,\gamma)^{65}Zn$ and $^{66}Zn(n,2n)^{65}Zn$. It is stated to be difficult to decide whether this radionuclide originates from the sixth or seventh Chinese test, but the probable origin was the thermonuclear test of June 1967. The Zn must have been used as a component of the construction material. Concentrations of radionuclides are tabulated covering the period July 1967 to June 1968. (UK)

465 ENVIRONMENTAL MONITORING OF NUCLEAR ESTABLISHMENTS. Roehnsch, W.; Kunert, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Kernenergie, 11: 209-14(Aug. 1968). (In German).

The review encompasses necessity and functions of environmental monitoring related to the handling of radioactive materials, aims, planning, international experiences with environmental monitoring, forecasts of developments, and environmental monitoring of nuclear establishments in the German Democratic Republic (the nuclear power plant at Rheinsberg, the Central Institute of Nuclear Research at Rossendorf, and the Division of Radioactive Wastes at Lohmen. (61 references) (P.G.C.)

466 RADIOACTIVELY LABELED AEROSOLS. Spurny, Kvetoslav R.; Lodge, James P. Jr. (National Center for Atmospheric Research, Boulder, Colo.). Atmos. Environ., 2: 429-40(Sept. 1968).

Radioactively labeled aerosol models are very useful in the experimental physics and chemistry of aerosols, and also in biological aerosology. Major methods for preparing radioactively labeled aerosols are classified, and previous publications dealing with work in this area are reviewed. Results of preparing radioactively labeled condensation aerosols and the experimental techniques used are described. (auth)

467 ON ANNUAL VARIATION OF STRATOSPHERIC ^{137}Cs IN FALLOUT AND OF BETA- AND LONG-LIVED ALPHA-ACTIVITY VARIATION IN 1966 IN VILNYUS. Garbalyauskas, Ch. A.; Luyanas, V. Yu.; Shpirkauskaite, N. K. At. Energ. (USSR), 25: 333-4(Oct. 1968). (In Russian).

Data obtained on radioactive fallout in Vilnyus in 1966 were compared with the data from 1964. Measurements of the β-activity of monthly samples ashed at ~500°C were carried out with the MST-17 counters. The spectral analysis of γ emission was made using an AI-100-1 analyzer with 40 × 40 mm NaI(Tl) crystal and FEU-13. Alpha activity of all monthly samples was determined simultaneously in May, 1967. Changes in the total α and β activities and concentration of ^{137}Cs in atmospheric fallout data on the yearly ratio of the amount of ^{137}Cs and total β activity, the total α activity of long lived elements in the fallout ($A_{^{137}Cs}/A_\alpha$ and A_β/A_α are given in graphic form. (R.V.J.)

Mineralogy and Exploration

468 (RME-150) PRELIMINARY RECONNAISSANCE FOR URANIUM IN ARKANSAS, ILLINOIS, KENTUCKY, MICHIGAN, MINNESOTA, MISSOURI, OHIO, AND WISCONSIN, 1952-1956. (Division of Raw Materials (AEC), Washington, D. C. Geological Survey [Washington, D. C.]). Aug. 1968. 89p. Dep. CFSTI.

Preliminary reconnaissance data for uranium prospecting in Arkansas, Illinois, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin from 1952 to 1956 are presented. The data includes the name and location of the deposit, published references, radioactivity measurements, geology of the deposit, directions to the property, owner or lessee, type of radiation detector used, and sample information. (R.C.K.)

469 (RME-151) PRELIMINARY RECONNAISSANCE FOR URANIUM IN KANSAS, NEBRASKA, AND OKLAHOMA, 1951-1956. (Grand Junction Office (AEC), Colo. Geological Survey [Washington, D. C.]). Aug. 1968. 73p. Dep. CFSTI.

Preliminary reconnaissance data for uranium prospecting in Kansas, Nebraska, and Oklahoma from 1951 to 1956 are presented. The data includes the name and location of the deposit, published references, radioactivity measurements, geology of the deposit, directions to the property, owner or lessee, type of radiation detector used, and sample information. (R.C.K.)

470 (RME-4103) PRELIMINARY RECONNAISSANCE FOR URANIUM IN MARYLAND AND PENNSYLVANIA, 1953-1957. (Division of Raw Materials (AEC), Washington, D. C. Geological Survey [Washington, D. C]). Aug. 1968. 80p. Dep. CFSTI.

Preliminary reconnaissance data for uranium prospecting in Maryland and Pennsylvania from 1953 to 1957 are presented. The data includes the name and location of the deposit, owner or lessee, published references, mine dimensions, radioactivity measurements, geology of the deposit, type of radiation detector used, and sample information. (R.C.K.)

471 (RME-4104) PRELIMINARY RECONNAISSANCE FOR URANIUM IN ALABAMA, GEORGIA, MISSISSIPPI, TENNESSEE, VIRGINIA, AND WEST VIRGINIA, 1950-1955. (Geological Survey [Washington, D. C.]). Aug. 1968. 77p. Dep. CFSTI.

Preliminary reconnaissance data for uranium prospecting in Alabama, Georgia, Mississippi, Tennessee, Virginia, and West Virginia are presented. The data includes the name and location of the deposit, radioactivity measurements, geology of the deposit, published references, type of radiation detector used, and sample information. (R.C.K.)

472 (RME-4105) PRELIMINARY RECONNAISSANCE FOR URANIUM IN NORTH AND SOUTH CAROLINA, 1953-1956. (Division of Raw Materials (AEC), Washington, D. C. Geological Survey [Washington, D. C.]). Aug. 1968. 72p. Dep. CFSTI.

Preliminary reconnaissance data for uranium prospecting in North and South Carolina from 1953 to 1956 are presented. The data includes the name and location of the deposit, radioactivity measurements, geology of the deposit, directions to the property, and owner, lessee, or contacts. (R.C.K.)

473 URANINITE LEADING TOURMALINE-SILLIMANITE PEGMATITE FROM THE GOTTHARD MASSIF. de Guervain, F. Vierteljahrsschr. Naturforsch. Ges. Zuerich, 110: 395-400 (Sept. 1965). (In German).

The U mineralization of the northern old crystalline paragneiss zone of the Gotthard massif is described. The base material is two types of pegmatite, both with tourmaline and muscovite; only one of these shows radioactivity. The activity is due to primary uraninite (cubic form of U pitchblende UO_2), most with UO_3, also with ThO_2, and also to several secondary U minerals. The uraninite is unaltered and enclosed in tourmaline crystals in all material examined. In some tourmalines it is present in a number of enclosures; others are quite free of uraninite. The secondary U minerals in the quartz-feldspar indicate earlier presence of uraninite outside the tourmaline. Some enclosures are idiomorphic, while others are skeletal, with a maximum dimension of 2 mm. The uraninite may have grown with zircon enclosures, which are not metamictic. The uraninite appears to have had no effect on the pleochroitic tourmaline. Pseudomorphoses of secondary products of uraninite are numerous. These include a hydrated U oxide and a phosphate, which is different from torbernite or chalkolith. (BBB)

474 STUDY OF THE RADIOACTIVITY OF SEPARATED MINERALS OF BEACH SANDS OF MANAVALAKURICHI, MADRAS STATE. Sastri, C. S.; Sivaramakrishnan, V. (Indian Inst. of Tech., Madras). Curr. Sci. (India), 37: 550(Oct. 5, 1968).

Sands containing ilmenite, rutile, zircon, monazite, and garnet are crushed to like sizes and studied for radioactivity content. (J.C.W.)

Oceanography

Refer also to abstracts 348, 442, and 597.

475 (NYO-3109-37(Pt.2)) ON THE PREDICTION OF THE PROBABLE DISTRIBUTION OF CONCENTRATION FROM HYPOTHETICAL RADIOACTIVE SOURCES ON THE CONTINENTAL SLOPE OFF THE EAST COAST OF THE U. S. PART II. THE PREDICTION OF CONCENTRATION BASED ON A MATHEMATICAL MODEL FOR SHEAR DIFFUSION. Okubo, Akira (Johns Hopkins Univ., Baltimore, Md. Chesapeake Bay Inst.). Sept. 1968. Contract AT(30-1)-3109. 105p. Dep. CFSTI.

A mathematical model for shear diffusion based on long-term current structures was devised to predict the probable distribution and dispersion of radioactivity from a radioactive source located at a depth between 1000 and 2000 m in the Atlantic Ocean. The model is applicable primarily to long-term diffusion. Small scale diffusion such as 10 to 100 m in length or 10 hrs in time is not represented properly by the model. (F.S.)

476 (USNRDL-TR-68-74) RADIOACTIVITY RELEASE FROM RADIONUCLIDE POWER SOURCES. VIIa. DISSOLUTION STUDIES OF PLUTONIUM DIOXIDE IN THE OCEAN, 5 MONTHS' EXPOSURE. Kubose, D. A.; Lai, M. G.; Goya, H. A.; Cordova, H. I. (Naval Radiological Defense Lab., San Francisco, Calif.). Apr. 16, 1968. Contract AT(49-5)-2084. 32p. Dep. CFSTI.

Post-ocean-exposure examinations have been made on plutonium dioxide microspheres recovered after a 5-month exposure on the bottom at a depth of 50 feet off San Clemente Island. These examinations established that approximately 70 percent of the microspheres became encrusted with marine growth. Determination of the distribution of the microspheres and adsorbed activity in the ocean-bottom material was made in addition to post-exposure laboratory dissolution measurements, microscopic examination and X-ray diffraction measurements. (auth)

477 SIMPLIFIED PROCEDURE FOR THE ESTIMATION OF ^{90}Sr IN SEA-WATER. Doshi, G. R.; Sreekumaran, C. (Bhabha Atomic Research Centre, Bombay). Curr. Sci. (India), 37: 554-6(Oct. 5, 1968).

A simplified method is given for the estimation of ^{90}Sr in seawater and may be applicable to sediment and biological materials. Ferric hydroxide is used for scavenging the fission products and naturally occurring radionuclides that interfere in the assay of ^{90}Y and also for collecting ^{90}Y after allowing it to come to equilibrium with its parent ^{90}Sr. The separation of ^{90}Y from the carrier ion is achieved by ion exchange. (J.C.W.)

Seismology

Refer also to abstracts 484 and 485.

478 (JAB-99-40) DIRECT-READING SCALER FOR MEASURING RECORDED WAVE DATA. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Oct. 1968. Contract AT(26-1)-99. 15p. Dep. CFSTI.

The magnitude of ground motion and structural motion can be read directly from seismographic records with the Direct-Reading Scaler. The description, design, and operation of the instrument is given. (J.C.W.)

479 EPICENTRES AND ORIGIN TIMES OF SOME LARGE EXPLOSIONS. Blamey, C.; Gibbs, P. G. Geophys. J. Roy. Astron. Soc., 16: 1-7(Sept. 1969).

A more accurate estimate of the relative positions of explosions in the U.S.S.R. and also in the Sahara was obtained. The joint epicenter method used was verified by locating a number of explosions at the Nevada test site, where accurately known shot points were available. The results obtained are compared with other methods. (auth)

480 EPICENTRE DETERMINATION BY SEISMIC ARRAYS. Lilwall, R. C. (Univ. of Birmingham, Eng.); Douglas, A. Nature (London), 220: 362-3(Oct. 26, 1968).

Methods of locating seismic events by combining data from several seismographic arrays are described. By using more than one array an increase in accuracy is obtained, without excluding the possibility of automation. Location of the nuclear explosion "Longshot" in the Aleutians was in error by 60 km and 150 km by two of the methods. (UK)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 362 and 461.

481 (AD–669844) OFF-SITE SURVEILLANCE FOR PROJECT STERLING. Carter, Melvin W.; Placak, O. R. (Public Health Service, Las Vegas, Nev. Southeastern Radiological Health Lab., Montgomery, Ala. Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Dec. 3, 1966. 46p. (ARPA-VUF–1036). CFSTI.

The information and data presented were compiled to summarize the activities conducted by the Off-Site Radiological Safety Organization relative to Project Sterling. The activities prior to the shot, during the active test period, and immediately post-shot are discussed. (auth) (USGRDR)

482 (AD–671642) GROUND SHOCK AND THE SURVIVAL OF THE CONTENTS OF PERSONNEL SHELTERS. Sawyers, Kenneth N.; Chilton, Frank M. (Stanford Research Inst., Menlo Park, Calif.). Nov. 1967. 56p. CFSTI.

A study was made of the feasibility of developing a reasonably simple method of predicting nuclear blast-induced ground motion in a wide variety of media and geology to assist OCD in shelter construction and emplacement. The approach is to use a generalized ray analysis in which velocity discontinuities in a linear elastic medium are considered to propagate along geometrical lines (rays) much as the propagation of light can be described. The ray method is exact for the amplitude of the first arrival or alternatively for the high frequency portion of the signal. To be fully useful to OCD, the prediction method should predict low as well as high frequency signals, since an observed characteristic of ground motion is an oscillatory waveform. Therefore, it is recommended that the analysis be carried out for media and yields for which there are experimental data for comparison purposes and as a step in the refinement of the method to include prediction of high- and low-frequency signals. (auth) (USGRDR)

483 (AD–671931) POINT EXPLOSION IN A COLD EXPONENTIAL ATMOSPHERE. Laumbach, Dallas D.; Probstein, Ronald F. (Massachusetts Inst. of Tech., Cambridge. Fluid Mechanics Lab.). May 1968. 52p. (Pub–68-3). CFSTI.

The problem considered is that of a strong shock propagating from a point energy source into a cold atmosphere whose density varies exponentially with altitude. An explicit analytic solution is obtained by taking the flow field as "locally radial" and using an integral method with an energy constraint. A scaling law is given which eliminates the parametric dependence of the solution on the explosion energy, scale height, and atmospheric density at the point of the explosion. The scaling law also transforms the infinity of solutions for various polar angles into two distinct solutions which show that all motions of the ascending portion of the shock may be scaled from the vertically upward behavior and all motions of the descending portion of the shock may be scaled from the vertically downward behavior. The limit in the lateral direction of both of the fundamental solutions corresponds to the case of the uniform density atmosphere. Comparison with finite difference calculations shows excellent agreement. The empirical concept of "modified Sachs scaling" for calculating the overpressure is considered and shown within this model to have a justification in the downward direction but a limited range of applicability in the upward direction. (auth) (USGRDR)

484 (PNE–513) SURFACE MOTION MEASUREMENTS. Project PRE-SCHOONER II. Christopher, W. G.; Larner, K. L. (Army Engineer Nuclear Cratering Group, Livermore, Calif.). May 1968. 47p. Dep. CFSTI.

Project Pre-Schooner II was a small-scale high explosive (HE) cratering experiment conducted as a part of a nuclear excavation research program. The 85.5 ton nitromethane charge was detonated on 30 September 1965 in hard, dry rhyolite rock at a depth of burst of 71 ft (scaled depth of 142 $ft/kt^{1/3.4}$ based on an energy equivalent yield of 94.1 tons). Surface ground zero (SGZ) was located approximately 40 miles southwest of Bruneau, Idaho. As a result of this experiment, knowledge of the surface motion phenomena of a cratering detonation was extended to the rhyolite medium. Gas acceleration appears to have been a much more important cratering mechanism in rhyolite than it was in HE cratering detonations in either basalt or clay shale. A peak spall velocity of 129 ft/sec occurred at SGZ 27 msec after zero time. Gas acceleration increased the SGZ velocity to about 220 ft/sec at the time of primary venting, 204 msec. The massive venting grew to a dome more than 200 ft wide at the time of total breakup of the material (about 600 msec after zero time). The peak spall velocities of the surface motion targets relative to the radial distance from the zero point (ZP) decayed approximately as follows: $V_s \propto R^{-3.0} \propto \cos^{3.0} \theta_T$ where V_s = peak vertical spall velocity (ft/sec), R = radial distance from ZP to preshot target position (ft), and θ_T = angle between vertical and line from ZP to preshot target position. The peak total velocities after initiation of the gas acceleration phase decayed essentially as: $V_t \propto R^{-3.3} \propto \cos^{3.3} \theta_T$ where V_t = peak total velocity after gas acceleration (ft/sec). The magnitude of the Pre-Schooner II SGZ peak spall velocity was comparable to the spall velocity obtained from the Danny Boy nuclear cratering detonation in basalt, but was much lower than velocities from comparable HE detonations in either shale or basalt. The Pre-Schooner II peak SGZ velocity at time of venting was higher than the peak velocities recorded from comparable nuclear or HE detonations in basalt or alluvium. The Pre-Schooner II peak SGZ velocity was somewhat lower than peak SGZ velocities observed during comparable HE cratering detonations in saturated clay shale. (auth)

485 (PNE–902-F) CLOSE-IN AIR BLAST FROM A CRATERING NUCLEAR DETONATION IN RHYOLITE. Project PALANQUIN. Final Report. Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Apr. 1966. 47p. Dep. CFSTI.

Close-in air-blast data from the 4.3 ± 0.4 kt Palanquin event in the Plowshare Program for development of nuclear excavation are presented and evaluated. When blast suppression factors are compared with those of past events, an effective yield of 2 kt is required to make Palanquin ground-shock-induced peak overpressures agree with those of past events. Four components of the blast wave from cratering explosions first observed on Project Dugout were again identified on Project Palanquin. The first two, the ground-transmitted, ground-shock-induced pulse and a Rayleigh-wave-induced pulse, are of academic interest. Of primary interest to Plowshare excavation projects are the air-transmitted, ground-shock-induced pulse (which dominated all the others) and the pulse from venting gases (for which the data suggest that peak overpressure may increase as the yield increases). Close-in pressures should be measured on any future event with a yield equal to or larger than Palanquin to resolve uncertainties created by the nature of Palanquin venting and to determine if there are nonscaling pressure increases with larger yields. The transition region between the epicenter and the genesis of the Rayleigh wave warrants investigation when the opportunity arises. (auth)

486 (PNE–3012(Vol.1)) AN ECONOMETRIC STUDY OF SMALL AND INTERMEDIATE SIZE DIAMETER DRILLING COSTS FOR THE UNITED STATES. Dagum, Estela M. Bee; Heiss, Klaus-Peter (Mathematica, Princeton, N. J.). June 30, 1968. Contract AT(04-3)-744. 126p. Dep. CFSTI.

Small and intermediate diameter drilling costs for Project Plowshare explosions were investigated. The hole depth and the geologic media in which the hole is drilled are the relevant variables in small diameter holes. Relevant variables in drilling intermediate diameter holes are diameter, depth, and hardness of the geologic media. Drilling costs increase more than proportionally with increased increments of diameter of the hole and hardness of geologic media. Costs increase linearly with depth. When casings are required, increased costs result. (F.S.)

487 (PNE–3013) COST-BENEFIT MODEL FOR NUCLEAR EXPLOSIVE STIMULATION OF NATURAL GAS RESERVOIRS. Dagum, Estela M. Bee (Mathematica, Princeton, N. J.). June 20, 1968. Contract AT(04-3)-744. 77p. Dep. CFSTI.

The use of nuclear explosives to stimulate low-producing natural gas fields raises the question of whether enough gas will be released to make such fields economically attractive. Therefore, a cost-benefit analysis of nuclear gas stimulation was prepared based on the amount of gas in place, the expected total recovery rate, and the distribution law of the annual production rates. A total of 120 possible production cases are considered. From this analysis it should be possible to determine either an upper limit for a profitable investment with a fixed gas recovery rate, or, conversely, the minimum recovery rate which would make a fixed investment economically feasible. (L.C.L.)

488 (PNE–G–4) PROJECT GASBUGGY: A GOVERNMENT-INDUSTRY NATURAL GAS PRODUCTION STIMULATION EXPERIMENT USING NUCLEAR EXPLOSIVES. (El Paso Natural Gas Co., Tex.). Sept. 15, 1967. 21p. Dep. CFSTI.

Project Gasbuggy is a joint experiment by the USAEC, Department of Interior, and the El Paso Natural Gas Company to investigate the feasibility of using an underground nuclear explosion to stimulate production and increase ultimate recovery of natural gas from a gas-bearing geologic formation of low productivity. A nuclear explosive equivalent to 26,000 tons of TNT is to be detonated 4,240 ft underground in a shale formation in a remote area of northwestern New Mexico. Complete and precise details are given on the background of this experiment, on the location, emplacement procedures, and geologic investigations which will be made during the experiment, and on the postshot evaluations of the seismic and radiological safety of the method and its overall usefulness for natural gas production stimulation. (L.C.L.)

489 (PNE-G-8) PROJECT GASBUGGY WELL TEST DATA. VOLUME II, SEPTEMBER 1967–SEPTEMBER 1968. (El Paso Natural Gas Co., Tex.). 276p. Dep. CFSTI.

All flow and pressure build-up data collected on all wells relative to Project Gasbuggy from September 1967 to September 1968 are presented. Included are data on: gas production; gas pressure, temperature, and volume measurements; gas pressure build-up on field wells and Gasbuggy test wells; bottomhole and surface pressure and temperature measurements; and gas and water analyses. Surface pressure shown throughout this data was measured with a deadweight gage, manometer, or a Heise gage. Bottomhole pressures were measured using Amerada Type bottomhole pressure gages. Flow rates were measured by using either an orifice meter, critical flow prover, orifice well tester, or a pitot tube. (L.C.L.)

490 (PNE-G-9) DRILLING AND TESTING OPERATIONS FOR PROJECT GASBUGGY. Cutler, W. G.; Kendrick, H. L. (El Paso Natural Gas Co., Farmington, N. Mex.). [1968]. 12p. (CONF-680926-3). Dep. CFSTI.

From AIME 43rd Annual Fall Meeting, Houston, Tex.

The mechanics of drilling and testing of the Gasbuggy site wells in the pre-shot and post-shot program are described. The information obtained from pre-shot well drilling and production testing of GB-1 and GB-2 wells confirmed the test site acceptability. The drilling discussion outlines the hole size, casing program, mud and gas drilling requirements, hydrological testing, coring, natural gas flow measurement and logging program. Hydrological testing of water-bearing strata above the Pictured Cliffs zone was performed to determine the quantity and quality of mobile water that might affect the experiment. The natural gas flow and shut-in well test data obtained while drilling and following completion of each well are presented. The mechanics of emplacement hole drilling, casing, loading and stemming for shot containment are discussed. Following the detonation of the device on December 10, 1967, the re-entry into the emplacement hole for preliminary sampling and chimney height determination is described. Post-shot pressure build-up data and gas sampling procedures are described. The re-entry drilling into GB-2R is described and the latest available test data relative to the flow rates and pressure data are presented. (auth)

491 (PNE-G-12) OPERATIONAL SAFETY ASPECTS OF PROJECT GASBUGGY. Thalgott, Robert H. (Nevada Operations Office (AEC), Las Vegas). [nd]. 6p. Dep. CFSTI.

All aspects of the Gasbuggy experiment which might affect the safety of the public were studied very carefully. Every precaution was taken to assure that there would be no accident, but that if an accident did occur plans were prepared for control so that there would be no undue hazard to anyone. The procedures were effective and the Gasbuggy device was detonated with no injury and a minimum of inconvenience to the population. (J.C.W.)

492 (PNE-G-13) STATUS OF RESERVOIR EVALUATION, PROJECT GASBUGGY. Ward, Don C.; Lemon, R. F. (El Paso Natural Gas Co., Tex. Bureau of Mines, Bartlesville, Okla. Bartlesville Petroleum Research Center). [1968]. 33p. (CONF-680926-4). Dep. CFSTI.

From AIME 43rd Annual Fall Meeting, Houston, Tex.

Results of drilling, logging, and testing of two preshot test wells at the Gasbuggy site confirmed the Pictured Cliffs gas reservoir to have substantial gas in place but extremely low permeability and productivity. Subsequent to detonation, the emplacement hole and one of the preshot test wells were reentered. Although a less than expected increase in productivity was observed in the test well, 300 feet from ground zero, significant productivity increase was demonstrated by a reentry well which connects with the nuclear created chimney. Further production testing is planned to permit more definitive evaluation of the effected stimulation. (auth)

493 (PNE-G-20) PROJECT GASBUGGY: WELL TEST DATA. Volume 1, February–September 1967. (El Paso Natural Gas Co., Tex.). 118p. Dep. CFSTI.

Flow and pressure buildup data collected on the three wells associated with Project Gasbuggy are presented in tabular form. Surface pressures were measured either with a deadweight gage or a manometer. Bottom hole pressures were measured using Amerada Type bottom hole gages. Flow rates were measured using either an orifice meter, critical flow prover, orifice well tester, or a pitot tube. (F.S.)

494 (UCRL-71280(Summ.)) PROJECT BUGGY: A NUCLEAR ROW EXCAVATION EXPERIMENT. Toman, John (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 13, 1968. Contract W-7405-eng-48. 6p. (CONF-681101-2). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

Results of a nuclear row cratering equipment, Project Buggy, are presented. Five nuclear explosives, each with a 1.1 kt yield, spaced 150 ft apart, and buried at a depth of 135 ft in a dry, complex basalt formation, were detonated simultaneously on Mar. 21, 1968 at the Nevada Test Site. The resultant channel excavated averaged 254 ft in width, 65 ft in depth, and was 855 ft long. These crater dimensions are significantly smaller than those predicted on the basis of previous experimental data in denser, more homogeneous Buckboard basalt, and indicate the effects of the physical properties of the rock bed. (L.C.L.)

495 (UCRL-71314(Rev.1)) GAS QUALITY INVESTIGATION PROGRAM STATUS REPORT FOR PROJECT GASBUGGY. Smith, Charles F.; Momyer, Floyd F. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 18, 1968. 30p. (PNE-G-10; CONF-680926-1). Dep. CFSTI.

From AIME 43rd Annual Fall Meeting, Houston, Tex.

Natural gas from the underground cavity produced by the Gasbuggy nuclear detonation was first sampled the day after the shot and has been monitored continuously since a month after the shot when the reentry drill hole penetrated the chimney. Results of chemical and radiochemical analyses of the gas are presented for the first seven months after the shot. At that time, 50 million ft^3 of the gas — including 30% of the amount originally in the chimney — was produced and flared in a 10-day period. Radiochemical evidence indicates that gas flowed rapidly into the chimney from the surrounding formation after the shot, as had been hoped. Preliminary evidence suggests that flaring the initial production of gas from the chimney may be a useful process for reducing the contamination level of the remainder of the gas. During the period of continuous monitoring between reentry and the production run, the major constituents of the cavity gas varied as follows: methane, increased from 37 to 44%; ethane, increased from 4 to 5%; propane, constant at about 1%; carbon dioxide, constant at about 36%; hydrogen, decreased from 17 to 12%; and carbon monoxide, decreased from 4 to less than 2%. The samples obtained the day after detonation indicated that much more significant changes occurred during the month before reentry. Major processes that could account for these changes include a reaction between water and carbon monoxide to produce hydrogen and carbon dioxide, followed by a series of reactions producing methane and ethane from the hydrogen and carbon dioxide. Krypton-85 and tritium are the major radioactive species in the gas. The concentration of ^{85}Kr remained fairly constant (about 2.8 $\mu Ci/ft^3$ NTP) throughout the test period. The form in which the tritium appeared changed during the period as the tritium atoms underwent chemical reactions. The predominant tritium-containing species, except at very early times after the shot, is tritiated methane at a concentration of 12 to 14 $\mu Ci/ft^3$ NTD. (auth)

496 (UCRL-71354) POSTSHOT GEOLOGIC INVESTIGATIONS, PROJECT GASBUGGY. Rawson, D. E.; Korver, J. A.; Pritchard, R. L.; Martin, W. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 25, 1968. 21p. (PNE-G-11; CONF-680926-2). Dep. CFSTI.

From AIME 43rd Annual Fall Meeting, Houston, Tex.

In the Gasbuggy experiment on nuclear stimulation of natural gas flow, the nominal 26-kt nuclear explosive was detonated on December 10, 1967, at a depth of 4240 ft, in the Lewis shale some 40 ft below its contact with the Pictured Cliffs gas-bearing formation. Postshot exploration of the chimney and the surrounding fractured region consisted of geophysical, chemical, and radiochemical investigations in the redrilled explosive emplacement hole (GB-E) and in the redrilled preshot hole GB-2, which was offset about 300 ft from the emplacement hole. Gas production testing was also done to assess in a preliminary way the effects of nuclear stimulation. The investigations of chimney size and extent of fracturing are reported. The Gasbuggy explosion produced a rubble-filled chimney about 80 ft in radius and 333 ft high. The reentry hole penetrated only the upper portion of the chimney, which appears to consist of sagged and slumped rock strata, with

a few rubble-filled voids. There is apparently no large void at the top of the chimney, as has been seen in other nuclear chimneys. It is thought that the horizontally bedded strata and the bulking characteristics of the rock with tensile failure are responsible for the lack of a void. The rock is fractured to some extent beyond the region of intense dynamic failure. This more distant fracturing takes place along pre-existing weaknesses such as bedding planes and, possibly, joints to at least 650 ft from the explosion, as evidenced by the offsets of drill hole casing in hole GB-2. Casing damage in the emplacement hole is observed at a depth of 3796 ft, or 444 ft above the explosion center. Brittle "Cliper" cables failed at the time of arrival of the shock wave to a distance of 500 ft from the explosion. Caliper logs and borehole photography in postshot GB-2 (GB-2RS) show that the coal layers of the Fruitland formation are intensely fractured to at least 500 ft from the shot point. Density and caliper logs indicate significant porosity increases in the lower interval of the Pictured Cliffs formation in GB-2RS. This region of the reservoir evidently was intensely fractured to at least 375 ft from the shot. Similar evidence plus gas production data indicate that intense fracturing took place in the Lewis formation to at least 400 ft. The Lewis formation did not produce gas preshot. The extent of intense dynamic fracturing is consistent with preshot estimates of 395 ft in the Pictured Cliffs formation and 490 ft in the Lewis formation. There appears to be a significant effect on the geometry of fracturing — beyond the range of intense dynamic failure — due to the bedded nature of the rock, the pre-existing weaknesses such as jointing, and, especially, the low density coals. The definition of changed effective permeability and its effect on the gas production is not as well documented as desired, but the deformational effects of the experiment, in light of the limited data, are at least as encouraging to nuclear stimulation as the preshot expectations. (auth)

497 COMMERCIAL PLOWSHARE SERVICES AND RELATED BACKGROUND MATERIAL. HEARINGS BEFORE THE SUBCOMMITTEE ON LEGISLATION, OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, SECOND SESSION, JULY 19, 1968. Washington, D. C., Joint Committee on Atomic Energy, 1968. 447p. GPO $2.25.

498 CALCULATIONS OF SHOCK WAVE EFFECT ON EXPLOSION PENETRATING RADIATION DOSE. Vilkov, V. P. At. Energ. (USSR), 25: 329-30(Oct. 1968). (In Russian).

An analysis of shock wave effects on the penetrating radiation dose from a nuclear explosion showed that the evacuated space inside the shock wave considerably influenced the absorption of γ radiation and neutrons up to $\tau = 1$ to 1.25. At larger values for τ the evacuated areas are determined by the explosion cloud. The divergence between the L_{eff} (effective evacuated area) and L'_{eff} referred to the L_{eff}: $\delta = (L_{eff} - L'_{eff}/L_{eff})$ and $L'_{eff} = R[1(\rho^*/{}^3\rho^{*-2})(R/R_f)^{3\rho^*+1}]$ which is the effective radius of the evacuated area obtained previously (R is the distance between the center of the explosion and the detector; R_f is the radius of shock waves, and ρ the dimensionless air density). Data analysis shows that the δ error depends on the parameter τ and on the relative distance R/R_f. In the event the detector is placed in front of the wave ($R/R_f \geq 1$), the magnitude δ does not exceed 12.5% in the assigned τ parameter range. In the event the wave front passes the detector ($R/R_f < 1$), the error in the magnitude of $L_{eff}(t,R)$ may reach 50% which reduces the dose by several times. (R.V.J.)

499 NICHTVERBREITUNG VON KERNWAFFEN. EIN PROBLEM DER FRIEDENSSICHERUNG. (Nonproliferation of Nuclear Weapons. A Problem in Peace Protection). Raiser, Ludwig. Forschungen und Berichte der Evangelischen Studiengemeinschaft. Band 22. Witten, Ger., Eckart-Verlag, 1968. 162p.

Six papers discussing various aspects of the political, scientific, economic, and strategic questions with respect to the treaty on the nonproliferation of nuclear weapons are presented. The history of the development of nuclear technology is summarized. Problems in the monitoring of the peaceful atomic technology and prevention of the spread of nuclear warfare are discussed. Inspection procedures as eventually outlined in the Non-Proliferation Treaty are discussed. Atomic control by the use of black boxes and not by inspection is also considered. Problems in the military and scientific utilization of nuclear energy posed by the treaty are discussed. The proposed draft of the treaty and formal comments by various organizations on the treaty are compiled. (J.S.R.)

Facilities and Equipment

Refer also to abstracts 425–427, 964, 1033, 1304–1306, 1316, 1317, 1335, 1731, and 2164.

500 (IA-1174) MINIMUM NUMBER OF OPERATIONS NEEDED TO IDENTIFY AN OBJECT IN AN ARRAY. Milman, Y. (Israel Atomic Energy Commission, Tel Aviv). May 1968. 11p. Dep.

The minimum number of operations for the complete identification of an object in an array under certain conditions is considered. A lower limit for this number is found, and the strategy of approaching that limit is derived. (auth)

501 (LA-DC-9545) EQUIPMENT AND TECHNIQUES FOR MEASUREMENTS OF THERMAL CONDUCTIVITY, THERMAL EXPANSION, AND ASSOCIATED PROPERTIES ABOVE 1000°C. Wagner, Paul (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 32p. (CONF-681104-1). Dep. CFSTI.

From 28th National Fall Conference of the American Society for Nondestructive Testing, Detroit, Mich.

Equipment and methods used in the measurement of thermophysical properties at temperatures between 1000° and 3000°C are reviewed. Included are designs for a box furnace for high temperature thermal expansion measurements on graphite, high temperature radial heat flow furnaces for measuring heat conductivity of solids and tubes, and a furnace for measurement of radial and axial components of heat conductivity. (F.S.)

502 (LA-DC-9866) ^{3}He–^{4}He DILUTION REFRIGERATORS. Steyert, W. A. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 7p. (CONF-681010-1). Dep. CFSTI.

From Helium Applications Symposium, Washington, D. C.

The design and uses of ^{3}He–^{4}He dilution refrigerators are discussed. These refrigerators make use of the heat absorbing process involved in dissolving ^{3}He into ^{4}He and will open a temperature regime two orders of magnitude lower than the 1°K available by pumping on liquid helium. Uses for the refrigerator include the study of nuclear decay schemes and in looking for parity nonconservation, time reversal non-invariance, and in nuclear polarization of high-energy accelerator targets. (F.S.)

503 (SC-DC-66-2428) FLUID POWER APPLIED TO HAZARDOUS LOCATION TEST EQUIPMENT. Oelsner, R. M. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 40p. (CONF-670451-1). Dep. CFSTI.

From 3rd Industrial Application of Fluidics Seminar, Milwaukee, Wis.

Severe restrictions are imposed on the designers of test equipment when the equipment is to be used in a hazardous location. Test equipment designers have combined fluid and electric power in a single automatic test system that meets the requirements of hazardous location use. (auth)

504 (TID-4100(Suppl.47)) ENGINEERING MATERIALS LIST. Kelly, Robert C. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Oct. 1968. 47p. DTIE Free.

Thirty-two packages of engineering materials are described. Drawings of the following equipment are included: extraction and strip columns, lens pulsers, accelerators and associated equipment, air bearing spindles, radiation detection instruments, shipping controls, cold traps, remote control systems, steam generators, pulse dividers, liquid metal vapor quality meters, plutonium buy back facility, amplifiers, oxygen meters, samples, manganin gages, UO_3 metal conversion plant, pipe jumpers, and fluid connectors. (R.C.K.)

505 (Y-JA-33) LEAK TESTING AND REPAIR OF HEPA FILTER BANKS. DeMonbrun, James R.; Choat, E. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 10, 1968. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A routine program for handling, installing, and testing HEPA filters is described. Quality assurance testing, inspection and installation, the HEPA filter frame, in-place efficiency testing, in-place leak testing, and repairs and modifications to stop leaks are discussed. (W.H.K.)

506 COMPARATIVE EVALUATION OF MAXIMUM STRESSES AT ABRUPT CHANGE IN WALL THICKNESS OF PRESSURIZED CYLINDER. Futterman, Stanley Roland (TRW, Redondo Beach, Calif.); Rubinstein, Moshe F. Nucl. Eng. Design, 8: 162-70(1968).

The maximum stresses at an abrupt change in wall thickness in an axisymmetric pressurized cylinder are calculated by the finite element method and by shell theory, and results are compared with experimental data. The experimental data confirm the validity of the finite element method. The results of the finite element solutions indicate that the stresses at the discontinuous surface are always higher than shell theory predictions, but do not always exceed the maximum stress found elsewhere on the cylinder. (auth)

507 IRRADIATION CAPSULE FOR A REACTOR. Hamada, Hiroya (to Meidensha Electric Mfg. Co., Ltd.). Japanese Patent 1968-13717. June 10, 1968. Filed Feb. 10, 1965.

An irradiation capsule is described for in-pile radioinduced chemical reactions using fission energy. The advantages are easy construction of the capsule, improved heat transmission from the inner container to the outer capsule-body, and reduced cost of the capsule. A concentric corrugation is made on the circumference of either the outer capsule-body or the inner container and by means of this corrugation, the two are held together tightly. A concentric corrugation in the capsule axial direction and an opposite-in-direction corrugation (i.e., troughs and crests of the corrugation run in the capsule axial direction) are made on the circumference of the outer capsule-body and the inner container, respectively, (or vice versa). The space between the end of the capsule-body and that of the container, on one side, is connected to the corresponding space on the other side. (NSA of Japan)

508 DOUBLE-WALLED EXPERIMENTAL HOLE IN NUCLEAR INSTALLATIONS. Kakimoto, Hiroshi (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1968-10716. May 9, 1968. Filed July 11, 1964.

Scattered radiation (gamma rays) through an experimental hole can be reduced considerably and yet the mechanical strength of the hole may be maintained adequately by double wall construction. An outer layer of a high atomic-number material such as lead alloy, and an inner layer of an anti-corrosion and -abrasion material such as an iron alloy constitute the hole construction. (NSA of Japan)

509 DESIGN CRITERIA FOR HIGH-PRESSURE, HIGH-TEMPERATURE BOLTING. A STATE-OF-THE-ART SUMMARY. Cooper, W. E. (Teledyne Materials Research Co., Waltham, Mass.); Widmer, R.; Brodrick, R. F.; Signorelli, J. A. Contract AT(30-1)-3660. Nucl. Eng. Design, 8: 125-42(1968).

The next generation of power-producing nuclear reactors is expected to operate at higher temperatures than reactors now in operation or under construction. These conditions will require that bolted closures in the systems be designed to operate under conditions not presently covered by ASME Codes. The anticipated needs of the nuclear industry, the availability of metallurgical data which would be required for codification to meet the anticipated needs, and the status and availability of stress analysis and methods and design criteria to apply to the new conditions are surveyed. It is found that closure temperatures up to 1300°F and pressures up to 4000 psi may be encountered. It is also found that, although creep data for bolting materials under consideration are available, stress-relaxation data are very meager. Further, methods for converting creep data to stress relaxation data are unreliable. (auth)

510 PNEUMATIC PANORAMIC IRRADIATOR. Masefield, J.; Rice, F. G.; Anderson, M. B.; Curnow, E. K. (to Atomic Energy of Canada, Ltd.). Canadian Patent 784,823. May 7, 1968.

Apparatus for irradiating a sample with high energy radiation is described. It consists of a lead screening mass to contain radioactive isotopes enclosed in several short capsules and a meandering tube joined to the irradiation position. The capsules are short so that they will not jam in the connecting meandering tube when moved through the tube by gas pressure. The curving tube prevents harmful radiation from reaching operating personnel. A fail-safe mechanism is also provided. The short capsules facilitate easy movement while allowing a large uniform irradiation field to be set up. (Canada)

511 CARBOHYDRATE ANALYZER PROTOTYPE-2 (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE-1779).

20 drawings.

A carbohydrate analyzer, designed for analysis of body fluids, is described. In the detection system a color is developed by a phenol–sulfuric acid reaction with carbohydrates. This system consists of a trickle-bed glass bead column in which the column effluent, 5% phenol and concentrated sulfuric acid are mixed; a reaction section maintained at 100°C; and a continuous flow colorimeter to measure the abundance of the reaction mixture at 480 and 490 mμ. The carbohydrate chromatogram shows the abundance of the column effluent as a function of time. The carbohydrate chromatogram requires 20 hr, and up to 48 peaks can be resolved from a single urine sample. (For details see TID-4100 Suppl. 48) (F.S.)

512 HIGH-TEMPERATURE HEAT-SHIELDED FURNACES: A REPORT FROM HARWELL. J. Fuel Heat. Technol., 15: 2-5 (Sept.-Oct. 1968).

The design, construction and commissioning of a suite of three high-temperature vacuum furnaces, required by the advanced fuel group of the Harwell Metallurgy Division for high-temperature materials research in advanced reactor studies are described. Mention is made of "Heatshield III," a computer program produced for predicting heatshield temperatures, and optimizing the number of shields required for specific applications. (auth) (UK)

513 200 kW ELECTRON BEAM MELTING FURNACE. Ind. Tech., No. 100, 31(Dec. 1967). (In French).

A 200 kW electron beam melting furnace for producing high purity niobium is described, which includes the following: the electron beam generator, and a vacuum working chamber equipped with two 11,000 l/sec pumping sets and various accessories. The installation is controlled from a desk with two work stations occupied in turn by a single operator. One station is used for cooling, for evacuating the chamber and for the electron beam generator. The other station is used for the functional operation of the furnace, energizing and focusing the generator, and actuation of the production accessories. (Sum. Articles Fr. Tech. Press)

514 LOW-TEMPERATURE IRRADIATION DEVICE FOR THE WWR-S REACTOR. Hoefgen, H. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 11: 215-20 (Aug. 1968). (In German).

In the Rossendorf WWR-S Research Reactor irradiations are carried out at 80°K by means of a vertical cryostat. The samples to be irradiated are embedded in liquid pure nitrogen (O_2 content <100 ppM) circulating in a closed circuit. The circuit is driven by utilizing a thermosiphon principle. The heat absorbed by the pure nitrogen is transferred to liquid technical-grade nitrogen in a heat exchanger. The fast neutron flux at the place of irradiation is $\Phi_s = 5.2 \times 10^{12}$ n cm^{-2} s^{-1} for a 4 MW power of the reactor. Under these conditions of irradiation the total consumption of the liquid technical-grade nitrogen in the cryostat, the injection pipeline, and the reservoir depends on the mass of the samples to be irradiated and amounts to 5 to 6.5 l per hour. (auth)

515 GLOVE BOX SYSTEM FOR A SPECTROPHOTOMETER. Costanzo, D. A.; Corbin, L. T. (Oak Ridge National Lab., Tenn.). Nucl. Appl., 5: 333(Nov. 1968).

A glove box system that permits the use of a standard spectrophotometer with either hot or cold solutions while keeping the instrument accessible for maintenance is described. (auth)

516 IMPROVEMENTS IN OR RELATING TO FILTER CELLS. (to Saint-Gobain Techniques Nouvelles). British Patent 1,128,064. Sept. 25, 1968. Priority date Dec. 29, 1964, France.

A filter cell containing high-efficiency or absolute filters used in filtering gases to remove extremely small radioactive particles is described. The filter cell consists of a casing containing an assembly of filter elements. Each filter element consists of one or more flat filter panels of folded filter paper mounted in a metal frame. The filter panels are assembled by means of a plastic material or cement. (F.S.)

517 EXTENDED REACH SEALED MANIPULATOR. (to Central Research Labs., Inc.). British Patent 1,132,680. Nov. 6, 1968. Priority date Oct. 28, 1966, United States.

A sealed remote-control master-slave manipulator in which movement of the master arm produces movements of the slave arm through a sealed barrier separating different environments is described. The slave arm may be lengthened independently of the master arm to extend the reach of the slave arm while maintaining the sealed barrier separating the environments. (F.S.)

518 METHOD OF AND APPARATUS FOR THE IRRADIATION OF FLUIDS, GRANULES, OR POWDERS. (to Saint-Gobain Techniques Nouvelles). British Patent 1,133,197. Nov. 13, 1968. Priority date Feb. 26, 1965, France.

Mobile equipment used in irradiating fluids, granules, or powders with a uniform dose is described. The material to be irradiated is passed through an arrangement of tubes positioned around a radioactive source in a shielded chamber. Each successive molecule or particle of material follows the same path and remains in the field of irradiation for the same length of time. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 345, 420, 421, 526, 571, 1248, 2027, 2085, and 2086.

519 (AAEC/TM-465) MEASUREMENT OF HEAT TRANSFER AND GAS FLOW RESISTANCE IN SQUARE SAMPLES OF PACKED BEDS. Manins, P. C.; Szomanski, E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 29p. Dep.

Experimental measurements of the average surface heat transfer coefficient in a randomly packed bed are reported. Rectangular sample beds with square cross section were cut from a large bed of zirconite sand balls frozen in wax. The wax was removed after their installation in special sample holders. The cyclic temperature variation measuring technique was used in conjunction with a high pressure carbon dioxide loop to permit measurements at high Reynolds numbers of interest. The heat transfer data obtained are consistent with those in the literature. Pressure drop measurements were also made and the flow resistance values for the samples appear to be low compared with the data for full sized beds. (auth)

520 (AAEC/TM–468) A LITERATURE SURVEY OF VERTICAL FORCED FLOW HEAT TRANSFER TO HIGH PRESSURE WATER BELOW AND BEYOND THE CRITICAL HEAT FLUX. Helms, R. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 14p. Dep.

A survey is given of the literature dealing with two-phase flow heat transfer. A summary of information on heat transfer in the various flow regimes is presented and the more widely accepted heat transfer correlation equations covering these regimes are given. Emphasis is placed on information relevant to geometries used in the coolant channels of water-cooled reactors. A bibliography of the source material comprising some 85 papers is included. The survey is intended in part as a useful guide for those new to the subject. (auth)

521 (AECL–2733) AN EXPERIMENTAL INVESTIGATION OF BOILING CHANNEL FLOW INSTABILITY. D'Arcy, Donald F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1968. 61p. (CONF-670912–4). Dep. CFSTI. CAN $1.50.

From Symposium on the Dynamics of Two Phase Flow, Eindhoven, Netherlands.

Experiments were conducted for the purpose of examining the threshold and nature of flow oscillations in parallel boiling flow channels. The test section comprised three internally heated annular flow channels connected via unheated pipes to inlet and outlet headers. The fluid was water at 500 to 1050 psi in forced circulation. The three heaters could be controlled independently up to 15 kW per foot each. The flow channels were vertical with 10 ft heated length. Mass fluxes up to about 10^6 lb/ft^2 hr could be achieved in the test section. Tests were performed by setting inlet subcooling and mass flux, then increasing power until either oscillating flow or dryout was observed. The range of inlet subcoolings was 15 to 150°F. Stability threshold data are presented for the basic geometrical configuration at about 1050, 850, and 550 psia. The effects of varying the channel equivalent diameter, heat flux distribution, inlet throttling and number of heated and unheated channels were investigated. In addition to threshold data, the oscillation frequency and wave shape were recorded. (auth)

522 (RT/ING–(68)9) HEAT TRANSFER NOTES. Cumo, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 299p. (In Italian). Dep.

Forced convection heat transfer was investigated through a series of topical studies. First single phase-forced convection typical coolants are considered (water, organics, liquid metals and gas), then boiling is studied, from subcooled through bulk boiling, and the departure from nucleate boiling depending on experimental conditions and duct geometry. There is particular insight on two-phase flows in which the liquid is the dispersed phase. Mixture constitution and cooling properties are studied. (auth)

523 (SU–247-14) HEAT TRANSFER FROM A PLASMA IN TUBE FLOW. Schmidt, Philip S. (Stanford Univ., Calif. Dept. of Mechanical Engineering). Sept. 1968. Contract AT(04-3)-247. 185p. Dep. CFSTI.

Heat transfer from a stream of partially ionized argon flowing in a water-cooled circular tube, ½ inch in diameter was investigated. Experiments were run with initial mixed-mean temperatures up to 21,000°R, at Reynolds numbers from 140 to 527 based on equilibrium properties evaluated at the entrance mixed mean temperature. Measured plasma flow Nusselt numbers computed on an enthalpy basis, $N_{Nu,h} = [qD/(k/c_p)_m\ (h_m - h_w)]$ were found to correlate well with low temperature constant property results in the region beyond 5 to 10 diameters downstream of the tube entrance; in the upstream region, Nusselt numbers were about 30% higher than constant property entrance region predictions. This tendency of the data to rapidly approach the constant property solution was predicted by the laminar finite-difference analysis for plasma tube flow developed by Incropera. The solution method was modified for this study to improve the accuracy of the predicted heat transfer and fluid friction parameters; the modifications are described in detail. The finite-difference theory underpredicted the heat transfer in the first few tube diameters; possible sources of the discrepancy are discussed, and several areas for further investigation of plasma internal flow are suggested. (auth)

524 HEAT TRANSFER AND FLOW CHARACTERISTICS IN CONDUCTIVE POROUS MEDIA WITH ENERGY GENERATION. Choudhury, Wasi Uddin. Madison, Wis., Univ. of Wisconsin, 1968. 247p.

Thesis.

Heat transfer and fluid flow characteristics in a conductive porous medium with uniform energy source were studied. The problem was two-fold: the formulation and solution of the pair of coupled, linear partial differential equations governing the transient heat transfer in a one-dimensional porous medium with a uniform internal energy source, and finite thermal conductivities of the solid and the fluid phases, and an experimental study comprising the measurement of the volumetric heat transfer coefficient, pressure drop, and friction factor between air and porous metallic specimens by a transient method. The solution of the partial differential equations, called the energy equations, was obtained by an implicit numerical method following the well-known technique of Crank and Nicholson. A second solution of the same equations was obtained by the Galerkin's error distribution method. The measurement of the volumetric heat transfer coefficient was made by a transient method by comparing the experimental temperature-time history with that obtained by the solution of the energy equations. Theoretical analysis of the equation of motion in porous media was also made. Equations correlating friction factor versus Reynolds number and pressure drop versus mass velocity evolved from this analysis which also gave the definition of characteristic length of the porous medium based on the viscous and the inertial coefficients. The friction factor in all four porous specimens ranged from 4 to 150, with the Reynolds number varying from 0.015 to 0.8. The correlation of heat transfer data was made by dimensional analysis. Generalized correlations have been obtained which fitted the data of all porous specimens. As a practical application of the results obtained in this investigation, the use of porous fuel elements in the nuclear reactor was considered. Some calculations have been made to show that the porous fuel elements may provide more power than the conventional solid fuel elements used at the present time. The solution of the energy equations showed that the effect of the thermal conductivity of the solid phase upon the temperature profile of the fluid phase was negligible; however, its effect upon the temperature of the solid phase was noticeable. The effect of the thermal conductivity of the fluid phase upon the temperature profile of the fluid phase was appreciable, although its effect upon the temperature of the solid phase was negligible. (Disser. Abstr.)

525 CROSS FLOW AND MIXING OF WATER BETWEEN SEMIOPEN CHANNELS. Hetsroni, G.; Leon, J.; Hakim, M. (Technion-Israel Inst. of Tech., Haifa). Nucl. Sci. Eng., 34: 189-93(Nov. 1968).

A study was conducted on the cross flow and mixing between water flowing in two semiopen channels. Measurements were made of the quantity of heat transferred between the hot and cold channels in a square array of parallel rods to determine the correlation between the ratio of the overall effective diffusivity for heat e to the kinematic viscosity ν and the flow Reynolds number Re. The results $e/\nu = 0.0061\ Re^{0.9}$ is in general agreement with previous results, but contains numerical coefficients not previously obtained for the present geometry. (auth)

Isotope Technology

Refer also to abstracts 432, 440, 441, 443, 445–450, 476, 537, 595, 596, 729, 737–740.

526 (ALO–3633-10) DEVELOPMENT OF 400 TO 2200F FIBROUS-TYPE INSULATIONS FOR RADIOISOTOPE POWER SYSTEMS. Quarterly Progress Report No. 7, July 1–September 30, 1968. Collins, J. O.; Jaunarajs, K. L.; Reid, D. R. (Johns-Manville Research and Engineering Center, Manville, N. J.). Oct. 1, 1968. Contract AT(30-1)-3633. 65p. Dep. CFSTI.

The study of the basic phenomenon of sintering, and particularly that of submicron silica and alumina particles was completed. Thermal stability, thermal conductivity porosity, and electron microscope evaluations all point to a particle agglomeration at temperatures lower than expected for these oxides. Materials studies were also completed for ALON-C, K_2CO_3 shrinkage inhibitor, and ZrO_2 opacifier combinations. In light of the agglomeration tendencies, the effect of the shrinkage inhibitor on the ALON-C must be studied over extended periods of life testing before the true product characteristics can be determined. Comparison of opacified and unopacified Glasrock foam silica thermal conductivities

at various densities showed the ineffectiveness of the opacifiers within the normal product density range. (auth)

527 (CEA-R-3456) DEVELOPMENT OF THE HIGH TEMPERATURE ION-SOURCE FOR THE GRENOBLE ELECTROMAGNETIC ISOTOPE SEPARATOR. Bouriant, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1968. 131p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

The production of high purity stable or radioactive isotopes (≥99.99%) using electromagnetic separation requires equipment having a high resolving power. In order to collect rare or short half-life isotopes, the efficiency of the ion-source must be high ($\eta > 5$ to 10%). The source operates at high temperatures (2500 to 3000°C) and makes use of ionization by electronic bombardment or thermoionization. A summary is given on the essential characteristics of the isotope separator ion-sources. A diagram of the principle of the source is given. Values of the resolving power and of the efficiency of the Grenoble isotope separator fitted with such a source are given. The resolving power measured at 10% of the peak height is of the order of 200. At the first magnetic stage the efficiency is between 1 and 26% for a range of elements evaporating between 200 and 3000°C. Thus equipped, the separator has for example produced, at the first stage, 10 mg of ^{180}Hf at (99.69 ± 0.1)% corresponding to an enrichment coefficient of 580. Recently 2 mg of ^{150}Nd at (99.996 ± 0.002)% corresponding to an enrichment coefficient of 4.2×10^5 has been obtained at the second stage. (auth)

528 (DP-1169-1) SAVANNAH RIVER LABORATORY ISOTOPIC POWER AND HEAT SOURCES. PART I. ^{60}Co. Quarterly Progress Report, April-June 1968. Hilborn, H. S. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). July 1968. Contract AT(07-2)-1. 15p. Dep. CFSTI.

Diffusion of ^{60}Co in TD Nickel Chromium was significantly slower when perpendicular rather than parallel to the extrusion direction. Oxidation of proposed capsule alloys at 1000°C was proportional to √time in 10,000-hour tests. Several nickel- and cobalt-based alloys are expected to have adequate oxidation resistance up to 5 years in air. Haynes 25, Hastelloy X, Hastelloy C, and Inconel 600 were selected as capsule materials for the first long-term tests of ^{60}Co capsules at 1000°C. Some of these capsules will have thermocouples with 0.040-in. dia sheaths spot-welded to the surface for accurate capsule temperature measurement. An Inconel 600 capsule containing radioactive cobalt was in satisfactory condition after 10,000 hours at about 900°C. (auth)

529 (JINR-P13-4061) GAS DISCHARGING ION SOURCE FOR THE ELECTROMAGNETIC MASS-SEPARATOR ON-LINE WITH THE HEAVY ION CYCLOTRON. Tarantin, N. I.; Dem'yanov, A. V.; Ivanov, N. S.; Kabachenko, A. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1968. 23p. (In Russian). Dep.

The gas discharging ion source is described which is used in the electromagnetic mass-separator on-line with the heavy ion cyclotron. This source is of the inverse-magnetron type, one of the peculiarities of which is, that the target, bombarded by the accelerated heavy ions, is located in the window of the discharging chamber so that the nuclear reaction products reach directly the ion source of the continuous mass-separator. The basic regularities of the charge in the ion source of this type are given. The efficiency of the separation, provided by this source on-line, is of 40 to 60% for Rn isotopes. (auth)

530 (N-68-29959) PROPERTIES OF SELECTED RADIOISOTOPES. PART 1. UNCLASSIFIED LITERATURE. A Bibliography. Harris, Dale; Epstein, Joseph (comps.) (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1968. 189p. (NASA-SP-7031). CFSTI.

Increasing interest in the application of substantial quantities of radioisotopes for propulsion, energy conversion, and various other thermal concepts emphasizes a need for accurate information describing the nuclear, chemical, and physical properties of these isotopes. An annotated bibliography and sets of properties for nine of the more attractive isotopes available for use in power production are presented. These isotopes are Strontium-90, Cesium-134, Cesium-137, Cesium-144, Promethium-147, Polonium-210, Plutonium-238, Curium-242, and Curium-244. (STAR)

531 (ORNL-4308) REVIEW OF ISOTOPES TARGET PROGRAM, JANUARY 1965-DECEMBER 1967. Kobisk, E. H. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 37p. Dep. CFSTI.

The reduction-distillation of metals and van Arkel-de Boer purification of isotopes methods of preparing high-purity isotopic materials are described. The vacuum evaporation technology of self-supporting films of bismuth, germanium, manganese, and silicon is discussed and methods presented. The new radioisotope facility is described. The preparation of targets for the High Energy Neutron Reaction Experiment (HENRE) is outlined. Target preparation methods for 72 elements with the resulting thicknesses are included. (J.C.W.)

532 KEY USES SEEN FOR ACTINIDE ISOTOPES. Chem. Eng. News, 46: No. 44, 54-5(Oct. 14, 1968).

A brief survey is presented of the production and uses of some transuranium isotopes: ^{238}Pu, ^{241}Am, ^{243}Am, ^{244}Cm, and ^{252}Cf. Some projected figures on the production of these isotopes in the future are given. Uses include heat and power sources, analysis and measurement, and medical treatment. The decay mode and radiation characteristics of the isotopes are described. (D.L.C.)

533 INCREASE IN DOSE OUTPUT BY USE OF A RADIATION SHIELD. Sauter, E. (Siemens AG, Erlangen, Ger.). Atompraxis, 14: 426-8(Sept.-Oct. 1968). (In German).

In special cases, shielding of a γ-source may increase the dose rate behind the shield. (auth

534 POWER SYSTEMS. Boretiz, J. E.; Jones, I. R. Space/Aeronaut., 50: 85-90(July 31, 1968).

Various space power systems including solar arrays as power sources, batteries, radioisotope thermoelectric generators, nuclear reactor heat sources, and radioisotope heat sources are reviewed. Recently, interest in radioisotope thermoelectric generators (RTGs) has increased as spacecraft designers have become increasingly aware of the many missions, with power requirements of up to about 1 kW, for which RTGs are either essential or show substantial advantages over nonnuclear systems. For deep-space probes, RTGs offer a decisive weight advantage. Reactor development work now is concentrated on the zirconium hydride, liquid-metal-cooled, and thermionic types. The zirconium hydride reactor, which can furnish from several kilowatts up to 100 kW of power, is probably the only one that will be available in the 1970's. It is also the only one that has been test-flown (when Snap 10A logged 1000 hr of satisfactory orbital operation in 1965). Work is also being done on combining zirconium hydride reactors with thermoelectric, organic-Rankine-cycle, and Brayton-cycle conversion systems. The liquid-metal-cooled reactor operates at much higher temperatures than does the zirconium hydride reactor (2000 to 2200°F as against 1300 to 1400°F) and is a fast reactor rather than a thermal one. An extensive technology effort is underway in connection with the development of a large (25-kWt) isotopic heat source that should produce 5 kWe when coupled to a Brayton conversion system. (BBB)

535 ORGANIC TRITIUM SOURCE FOR BETA RAY SPECTROSCOPY. Daris, R.; St.-Pierre, C. (Laval Univ., Quebec). Nucl. Instrum. Methods, 64: 346-8(Oct. 1968).

A technique has been devised to prepare very thin tritium sources meeting the requirements for high resolution beta spectroscopy. A special attention is paid to the stability of the source. (auth)

536 IMPROVEMENTS RELATING TO ISOTOPIC HEAT SOURCES. (to Nuclear Materials and Equipment Corp.). British Patent 1,133,299. Nov. 13, 1968. Priority date Oct. 27, 1966, United States.

An isotopic heat source capsule for use with a high temperature thermoelectric converter which changes heat energy to electric energy and which operates at 1000°C or higher is described. The capsule is cylindrical with bellows-shaped walls closed at both ends. A nosepiece located at one end is filled with an energy absorber such as fine celled Mo or Be honeycomb to protect the end closure against critical altitude impact. (F.S.)

Materials Testing

Refer also to abstracts 503, 565, 570, 572, 574-577, 579, 581, 586, 587, 588, and 991.

537 ISOTOPE HEAT SOURCE TESTER (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE-1781).

24 drawings.

An ultrasonic tester to nondestructively test cylindrical isotopic heat sources for end cap welds, wall weld penetration and cracks, wall defects, and to measure wall thickness is described. The tester consists of an electronic console and a mechanical device to rotate the sample. (For details see TID-4100 Suppl. 48) (See also 22: 25524). (F.S.)

538 NEUTROGRAPHY: TECHNIQUE FOR THE EXAMINATION OF MATERIALS BY THEIR TRANSPARENCY TO NEUTRONS. Meriel, Yves. Sci. Progr.-Nature, No. 3400, 293-6 (Aug. 1968). (In French).

The technique of neutrography is briefly outlined. The attenuation coefficient is defined. The neutron sources and detection procedures commonly used are described. Some applications of this technique are indicated. (J.S.R.)

539 METHOD AND APPARATUS FOR INSPECTING TRANSPARENT ARTICLES FOR DEFECTS BY FLUORESCENT RADIATION. Baker, Theodore C. (to Owens-Illinois, Inc.). U. S. Patent 3,394,263. July 23, 1968. Filed Dec. 28, 1964.

Equipment and methods are described for inspecting transparent materials for defects by fluorescence analysis using ultraviolet radiation and soft x-ray sources. (B.G.D.)

540 LEAKAGE RATE MEASUREMENTS BY MEANS OF OXYGEN DETERMINATION. Kuypers, J.; Ruiter, J. P. (N. V. tot Keuring van Electrotechnische Materialen, Arnhem, Netherlands). Nucl. Appl., 5: 354- (Nov. 1968).

A method is described for measuring leakage in large vessels by catalytically removing the oxygen from the test vessel and determining the oxygen content of in-leaking air. (J.R.D.)

Protective Structures

541 EFFECTS OF GROUND ROUGHNESS ON FALLOUT PROTECTION FACTORS. French, R. L.; Price, J. H. (Radiation Research Associates, Inc., Fort Worth, Tex.). Nucl. Appl., 5: 334-43(Nov. 1968).

Ground roughness effects were considered in Monte Carlo calculations of the protection factor of a cylindrical concrete structure exposed to an infinite plane ^{60}Co source (~1.25 MeV gamma) assumed to be representative of fallout. The "buried-source" model with source depths of 0, 0.5, and 1.0 in. was used to simulate smooth, rough, and very rough ground, respectively. The simple structure had a 10-ft radius and wall mass thicknesses of 20, 40, and 80 lb/ft^2–db/ft^2. The quantities calculated included the distribution of energy and of angle of the photons incident upon the structure with detector heights of 3, 13, and 23 ft inside. Ground roughness was found to enhance the protection factor of the structure by reducing the incident radiation intensity and by altering the energy and angle distribution of the incident radiation. The first effect was generally about twice as strong as the latter. Both effects are largest for the 3-ft detector height where, for all wall thicknesses, the protection factors were increased by a factor of ~4.5 by very rough ground. Calculations performed with the engineering method including ground roughness effects accounted for only ~75% of the protection factor enhancement, but a simple modification produced results that generally agreed within 10% with the Monte Carlo results. The modification consists of adding a fictitious height to the detector height before evaluating the directional response function $G_d(\omega,H)$. (auth)

Radioactive Material Handling

Refer also to abstracts 336, 351, 465, 517, and 635.

542 (AEC-tr-6881) TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES. Spitsyn, E. Ya. Translation of Pererabotka i Zakhoronenie Radioaktivnykh Otkhodov Laboratorii, Atomizdat, Moscow, 1965. 107p. (TT-68-50326; IPST-Cat.-5084). Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 27839. (R.C.K.)

543 (AERE-M-2087) THE DESIGN AND TESTING OF A TRANSPORT CAPSULE TO MEET THE I.A.E.A. REGULATIONS. Dixon, F. E.; Davies, A. J. (Atomic Energy Research Establishment, Harwell (England)). July 1968. 10p. Dep. CFSTI. UK 3s. 0d.

An account is given of tests on a stainless steel capsule designed for irradiated specimens, which is capable of being loaded and unloaded in radioactive cell. It is shown that not all types of seal are suitable, and a satisfactory design is described. (auth) (UK)

544 (BNWL-824) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, February-April 1968. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 1968. Contract AT(45-1)-1830. 26p. Dep. CFSTI.

Approximately 3,000,000 Ci of radioactivity were successfully processed in two phosphate glass runs in WSEP. These runs represent the fourth and fifth conversion of highly radioactive wastes into glass on an engineering scale. Phosphate glass Run PG-4 was made using sulfate-containing Purex Waste 2 (PW-2) feed while PG-5 was made using sulfate-free Purex Waste 1 (PW-1) feed. Leach rates on phosphate glass solids from WSEP were 1×10^{-6} to 2×10^{-7} $g/cm^2/day$. Platinum corrosion was evaluated for sulfate-free phosphate glass flowsheets made with excessive phosphate, lead, and silicone antifoam agent. Significant platinum corrosion occurred only in the vapor phase with high phosphate feed and in the melt phase with feed containing lead. There was no evidence of cracking or embrittlement. Testing of low-salt flowsheets was carried out on the developmental spray solidifier. Major characteristics were a reduced capacity in the calciner, reduced denitration of the powder from spray calciner, and increased difficulty in removing the calcined powder from the spray calciner filters. Batch discharge of the melt from the melter allows filling of an unheated container. A simulated spray-solidified melt prepared from low-salt PW-4 solution corroded both 304-L and 310 stainless steel at a rate of about 15 mils/month in 100 hr tests at 800°C. Addition of formaldehyde or hypophosphorus acid to spray solidifier feed reduced the volatility of Ru significantly. Laboratory tests with commercial silicone antifoam agents were successful in reducing DBP-induced foaming in phosphate glass runs. Equipment is being fabricated for studying pressure buildup in high sulfate wastes stored with a molten core. (auth)

545 (CEA-R-3459) IMMEDIATE SUPERVISION OF THE COASTAL SITE AT THE LA HAGUE CENTRE. Scheidhauer, Jean (Commissariat a l'Energie Atomique, La Hague (France). Mar. 1968. 39p. (In French). Dep.

The disposal into the sea of the residual waters from a plant processing irradiated fuels and the corresponding coastal zone are under surveillance. The material and the sampling techniques are described along with testing of flora, fauna, sediments, and seawater. Analytical and routine measurement methods are presented. (auth)

546 (CONF-681001) PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON PACKAGING AND TRANSPORTATION OF RADIOACTIVE MATERIALS, GATLINBURG, TENNESSEE, OCTOBER 14–18, 1968. (Oak Ridge National Lab., Tenn.). 723p. Dep. CFSTI.

Fifty-seven papers were presented at the conference. A separate abstract was prepared for each of 44 papers. Seven papers have previously appeared in NSA. For abstracts of these see CONF-681001 in the Report Number Index. Six papers were not included in the published proceedings. (L.C.L.)

For abstracts of individual papers see: 547–564, 566–569, and 571–590.

547 (CONF-681001-, pp 1-13) THE COMPETENT AUTHORITY: HOW IS HE COPING? Wilson, E. J.; Partridge, A. H. (Ministry of Transport, London (England)).

The problems associated with the implementation of the IAEA transport regulations and how they affect the competent authority, are discussed. Included are spillages on highways and the U.K. emergency NAIR (National Arrangements for Incidents Involving Radioactivity) scheme for dealing with them. (auth)

548 (CONF-681001-, pp 14-27) NEW REGULATIONS AND THEIR IMPACT ON THE TRANSPORTATION OF RADIOACTIVE MATERIALS. Blackburn, R. W. (Atomic Energy Control Board, Ottawa (Ontario)).

The new regulations for the transportation of radioactive materials were prepared by the International Atomic Energy Agency (IAEA) and are being adopted by most nations of the world. The new regulations provide safety and economic advantages because of their rational bases, intermodal and international uniformity, and flexibility. The impact of the new regulations on the general public, shippers, carriers, transport facility operators, packaging designers, and regulatory authorities and the responsibilities of these groups in the application and continuing development of the new regulations are discussed in the context of Canadian experience. (auth)

549 (CONF-681001-, pp 28-36) MAIN PROBLEMS ARISING FROM THE APPLICATION OF IAEA RECOMMENDATIONS. Sousselier, Y.; Bouillet, J. (Commissariat a l'Energie Atomique, Paris (France)).

The IAEA Recommendations for the transport of radioactive materials have been faithfully implemented in all the specific sets of international regulations and were widely taken into consideration in national regulations in most countries involved in the transport of radioactive materials. The application of these requirements seemed to raise some problems in the light of experience. Faced with the prospect of the recommendations in question being revised within the next two or three years, the main problems which might arise are discussed. These questions are of two types: theoretical and technical problems which relate to the

manifestation or to the level of activity limits, to certain packaging requirements, and to certain nuclear safety criteria. Suggestions are made for overcoming these problems; and administrative problems, i.e., the difficulties encountered in international transport arise from the absence of worldwide agreement. Specific sets of international regulations only cover legally-defined geographical areas for a specific mode of transport. Recommendations are made as to possible ways of dealing with these problems. (auth)

550 (CONF-681001–, pp 37-46) IMPLEMENTATION OF THE NEW AEC TRANSPORT REGULATIONS–10 CFR 71. Nussbaumer, Donald A.; MacDonald, Charles E. (Division of Materials and Licensing (AEC), Washington, D. C.).

A completely revised regulation — 10 CFR 71 — governing the packaging for transport of fissile material and large quantities of radioactive materials became effective in August, 1966. The concepts or performance standards of this regulation are based on those developed by the IAEA and incorporated in their regulations. The effect of Part 71 was to require that all existing licensed containers as well as new containers be evaluated in terms of the new performance standards. It appears that a discussion of the experiences to date on implementing the revised Part 71 would be of interest by describing typical containers which meet the regulatory requirements, identifying problem areas encountered and how they were dealt with. The identification and description of the typical features of containers used for the various types and forms of material being shipped, e.g., UF_6, metal, oxide, solutions, fuel elements, and scrap are presented. The basis for safety of each of the typical containers is described from both the structural integrity and criticality control standpoint. Application of certain aspects of the performance standards to types of shipments such as UF_6, plutonium nitrate, and low-enriched uranium oxide is described. Possible changes in the regulations are identified and discussed. (auth)

551 (CONF-681001–, pp 47-61) REVIEW OF IMPLEMENTATION OF TRANSPORT REGULATIONS FOR CRITICALITY CONTROL. Bidinger, G. H.; Odegaarden, R. H. (Division of Materials and Licensing (AEC), Washington, D. C.).

Reviews of approximately one hundred requests for authorization to package fissile material for shipment have been made by the USAEC regulatory staff since the transport regulation, 10 CFR Part 71, became effective in August 1966. The difficulties that licensees have encountered in satisfying the safety standards of Part 71 are summarized. Recommendations are given for increasing the calculated allowable number of packages in a shipment while maintaining the required margins of safety. (auth)

552 (CONF-681001–, pp 62-71) COAST GUARD AND MARITIME RADIOACTIVE MATERIALS TRAFFIC. Grant, T. R. (Coast Guard, Washington, D. C.).

The carriage of radioactive materials on board a merchant ship presents several problems differing in kind and degree from those encountered in land transportation. The Coast Guard is charged by law with the regulation of such cargoes, to prescribe safe conditions on the ships and in the ports through which it passes. The responsible staff works closely with other components in the Department of Transportation in developing regulations and in administering the special permits program. Helping shape the regulations for water transportation are considerations relating to the maritime environment, technological change in the merchant marine, international comity, and personnel exposures to radiation. (auth)

553 (CONF-681001–, pp 72-90) ADMINISTRATION OF RADIOACTIVE MATERIALS TRANSPORT: OAK RIDGE OPERATIONS. Pryor, W. A.; Hardin, T. H. (Oak Ridge Operations (AEC), Tenn.).

Radioactive materials in essentially all forms and in large quantities are routinely shipped from the installations under the jurisdiction of the U. S. Atomic Energy Commission's Oak Ridge Operations. The administration of this radioactive materials transport in domestic and international commerce within established rules and regulations from three principal production and research complexes are described. Safety and traffic management implications are emphasized. (auth)

554 (CONF-681001–, pp 91-8) HIGH COST OF RED TAPE. Brobst, William A. (Department of Transportation, Washington, D. C.).

The difficulties encountered by the atomic energy industry in arranging for governmental approvals for transportation of radioactive materials are discussed. What can be done about the high cost of governmental paper work requirements? A number of possible solutions are suggested. (auth)

555 (CONF-681001–, pp 99-113) IAEA REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS. Swindell, G. E. (International Atomic Energy Agency, Vienna (Austria)).

An account is given of the development of the IAEA Regulations for the Safe Transport of Radioactive Materials in response to a resolution passed in 1959 by the Economic and Social Council of the United Nations. These regulations were drawn up in consultation with the United Nations and its specialized agencies and with other international organizations concerned with transport. The extent to which they have been adopted by international organizations and Member States is reviewed and some of the difficulties experienced in their implementation are described. A provisional time-table is given for the successive steps in the next revision of the regulations. (auth)

556 (CONF-681001–, pp 114-17) REA EXPRESS PROBLEMS IN THE TRANSPORTATION AND HANDLING OF SHIPMENTS OF RADIOACTIVE MATERIALS. Toughey, J. J. (R E A Express, New York).

REA, as a common carrier, is neither required to, nor able to, inspect shipments of radioactive materials prior to accepting them. The shipper is required by law to properly pack, address, describe and classify radioactive materials prior to offering them to REA. Certification to this effect must appear on the REA waybill. If shipments are prepared in accordance with existing regulations, REA is able to safely transport them to destination, but if they are not, problems of a dangerous nature often arise. (auth)

557 (CONF-681001–, pp 118-23) OPERATING EXPERIENCE IN RADIOACTIVE SHIPMENTS. Byrom, John P.; Anselmo, Alfredo A. (Idaho Nuclear Corp., Idaho Falls).

The shipping of radioactive materials from the NRTS during 1951 to 1967 is discussed with particular emphasis on radiation, contamination, and tie-down problems. The shipments ranged in size from a few pounds to a 60,000-pound container and a railcar shipment of approximately 70 tons. The methods of transportation of these shipments included parcel post, railcars, commercial truckline, aircraft, and ocean vessels. The activity ranged from low-level (barely detectable) induced activity to millions of curies. The transport problems and accidents experienced are primarily those incident to any other large freight shipment and are not those inherent to radioactive material. The problems experienced in these shipments are discussed in the light of ICC, DOT, IAEA, and local NRTS-ID regulations. This includes that class where there apparently were no directly applicable regulations. The methods used to determine contamination and radiation levels are discussed, along with problems encountered using these methods. Until the Hot Cell was built at the MTR, container loading procedures used were primarily those of underwater loading. Total shipments from the NRTS in 1966 included 88 round-trip truckloads by special carrier, covering 340,000 miles, and an accumulated shipping container weight of some 4.5 million pounds. In addition to the special truckloads indicated, approximately an additional 15 percent of the radioactive materials shipments were made by other commercial carriers. The accident rate experienced to date had been one major and six minor incidents during 16 years of operation. (auth)

558 (CONF-681001–, pp 124-35) LEGAL PROBLEMS IN THE TRANSPORTATION OF RADIOACTIVE MATERIALS. Howard, Edward G. (Association of American Railroads, Washington, D. C.).

Some legal problems encountered in shipping radioactive materials by railway are discussed with particular emphasis on the financial responsibility of the carrier in case of an accident which results in radioactive contamination. Amendments to existing legislation on the transport of radioactive materials are recommended. (L.C.L.)

559 (CONF-681001–, pp 154-9) SPENT-FUEL RECEIVER'S POINT OF VIEW AND EXPERIENCE. Rogers, R. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant).

Over the last several years, the reactor operator, shipper, and carrier have all discussed their practices and problems in the transportation of spent reactor fuel. The fuel receiver has not yet been heard from, and so some of the problems shared by all receivers are discussed. It is hoped that Savannah River Plant experience with these problems may prove helpful to future receivers and processors, as well as shippers and carriers. (auth)

560 (CONF-681001–, pp 160-86) EXAMINATION OF RADIUM LOSSES DURING TRANSPORTATION. Schmidt, Gail D. (National Center for Radiological Health, Rockville, Md.).

Nationwide searches have been conducted for sealed radium

sources lost during transportation. An examination of these incidents indicate that the primary cause was the unfamiliarity of the shipper with the regulatory requirements for packaging and shipment of radioactive material and a lack of appreciation of the structural requirements necessary to maintain integrity of the package during normal conditions of transportation. Recommendations, which include a positive closure device, integral with the shield and a minimum size inner container, are made to prevent future losses. (auth)

561 (CONF-681001–, pp 187-98) AEC HEADQUARTERS DIVISION OF CONSTRUCTION'S SHIPPING CONTAINER PROGRAM PROGRESS REPORT. Sisler, James A. (Division of Construction (AEC), Washington, D. C.).

Within the Division of Construction, the Transportation Management Branch, AEC Headquarters, has been assigned responsibility for Headquarter's coordination of activities directed toward the development of improved methods and procedures for the shipment of radioactive and fissile materials, including providing for effective utilization of shipping containers. Several aspects of the container program are reviewed including the utility review procedure, the promotion of specification containers, and the container inventory. Also discussed are several of the problem areas encountered in coordinating the program, the progress made, and the future plans concerning the AEC's radioactive and fissile material shipping container program. (auth)

562 (CONF-681001–, pp 199-209) ACCIDENT EXPERIENCE OF THE USAEC IN THE SHIPMENT OF RADIOACTIVE MATERIAL. Patterson, D. E. (Division of Operational Safety (AEC), Washington, D. C.).

U. S. Atomic Energy Commission (AEC) contractors have been shippers of radioactive materials for more than twenty years. Since 1949, a record has been accumulated of transportation accidents which have involved these shipments. Based on an analysis of this experience, it is predicted that, during the near future, accidents can be expected at a rate of 30 per year. However, it is expected that in eight accidents only will the material be released from the package and that in three accidents only will the material escape beyond the confinement of the vehicle. The new Department of Transportation (DOT) Regulations are not expected to affect the accident experience. (auth)

563 (CONF-681001–, pp 210-21) SHIPMENT OF IRRADIATED FUEL FROM POWER REACTORS IN THE 1970's. Smith, C. W. (General Electric Co., Santa Clara, Calif. Nuclear Energy Div.).

The continuing progress of the nuclear power industry in the 1970's will present many challenges in providing safe, reliable shipment of irradiated fuels at reasonable costs. Fuel assembly lengths will increase to about 180 inches and specific powers and exposures will increase by factors of $1\frac{1}{2}$ to 2. The amount of irradiated fuels will increase by a factor of about 50 during this time and will provide an annual freight volume of several hundred thousand tons by 1980. The weight-capacity relationship of equipment used to transport irradiated fuels is important to both safety and economics and indicates that the need to transport loads up to about 100 tons will continue through the 1970's. Heat transfer and containment will be the principal technical problems resulting from higher specific powers and exposures of the newer fuels. Experience with irradiated fuel shipments has been favorable and indicates that shipments in the 1970's should move as normal freight. Regulatory action should move toward continuance of performance-type regulations, broad licensing of containers, and reduction of paperwork. Cooperation of all parties involved is required to achieve the objective of safe, reliable, economical, transportation of irradiated power reactor fuels in the 1970's. (auth)

564 (CONF-681001–, pp 222-30) PRICING, PURCHASING, AND MANAGING TRANSPORTATION OF RADIOACTIVE MATERIALS. Goodner, C. F. (Richland Operations Office (AEC), Wash.).

The historical background of freight rates now in effect on radioactive materials is discussed. It relates a number of experiences encountered in the negotiations of rates on certain large movements. Some do's and don't's are suggested for both carriers and shippers. These latter cover snares and pitfalls to avoid in making rates, in carrier selection, and physical handling of the traffic. (auth)

565 (CONF-681001–, pp 245-52) BRITTLE FRACTURE PROBLEMS IN RELATION TO THICK WALLED PACKAGING. Wilson, E. J.; Partridge, A. H. (Ministry of Transport, London (England)).

The IAEA Transport Regulations in drawing up packaging and package design criteria, have defined certain temperature limitations and have specified the need to give particular attention to the problems of brittle fracture. The problem in relation to a flask design incorporating steel plates 14.5 inches thick and weighing some 50 tons is considered. The discussions of the problem are summarized. (auth)

566 (CONF-681001–, pp 253-67) EXPERIMENTAL AND ANALYTICAL DEVELOPMENTS AT OAK RIDGE NATIONAL LABORATORY FOR DEMONSTRATING SHIPPING CASK COMPLIANCE WITH FEDERAL REGULATIONS. Evans, J. H.; Nelms, H. A.; Stoddart, W. C. (Oak Ridge National Lab., Tenn.).

The experimental data, analytical techniques, and planned testing programs developed to demonstrate the structural compliance of shielding shipping casks for radioactive materials with the accident portion of the Federal Regulations 10 CFR 71 are described. (auth)

567 (CONF-681001–, pp 268-77) ENGINEERING DESIGN GUIDE FOR IRRADIATED FUEL SHIPPING CASKS. Shappert, L. B. (Oak Ridge National Lab., Tenn.).

A program was organized in the early part of 1966 to develop Engineering Standards and Guide to the Design of Shipping Casks. The Guide provides information on cask design based on extensive cask testing and present engineering practice, discusses cask structural integrity, heat transfer, criticality, shielding, materials of construction, and fabrication techniques in detail. Examples of the information presented in the Guide are presented. (auth)

568 (CONF-681001–, pp 278-84) MATERIALS OF CONSTRUCTION, FABRICATION CONTROLS, AND TESTS FOR RADIOACTIVE MATERIAL SHIPPING CONTAINERS. McGuffey, J. R. (Oak Ridge National Lab., Tenn.).

Existing national codes are not directly applicable to all phases of the design, fabrication and testing of shipping containers used to transport radioactive materials. The U. S. Atomic Energy Commission has therefore requested the Oak Ridge National Laboratory to prepare an Engineering Design Guide for the designers, purchasers and manufacturers of such equipment. Recommended materials of construction are described. In selecting materials particular emphasis was given to the regulatory requirement that the metal have adequate toughness at −40°F. A quality assurance program to be used during fabrication and testing of shipping containers is outlined. Material on these two aspects of the design guide is presented. (auth)

569 (CONF-681001–, pp 285-90) STATUS OF STANDARDS FOR TIEDOWN. Langhaar, J. W. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Atomic Energy Div.).

Some casks have been shipped with attachments to the vehicle, or tiedowns, obviously incapable of resisting rough handling within the range of ordinary transport. A subcommittee of the U.S.A. Standards Institute, and previously of the American Standards Association, has for more than two years been seeking an answer to the question of how strong the tiedown should be. It was disturbing to discover that suitable basic information is hard to come by, and may necessitate experimental work. Meanwhile, preparation of a guide has been undertaken, to describe many of the methods of tiedown now in use. (auth)

570 (CONF-681001–, pp 292-305) PROBLEM OF DEMONSTRATING RESISTANCE TO FIRE. Langhaar, J. W. (Du Pont de Nemours (E. I.) and Co., Wilmington, Del. Atomic Energy Div.).

Demonstration of resistance to impact and fire is most convincing when tests are performed with full-size packaging. Such tests with containers having Celotex insulation inside 55 and 80 gallon drums are described, particularly with respect to unexpected and continued smoldering after the fire. Full scale testing is often not economically feasible. Calculation as the sole method of assessing resistance to fire is unreliable in some respects, because of the questionable extent of damage from the presumed impact preceding the fire and because many transient phenomena, such as the movement of lead, cannot be predicted. The negative results of an experimental program for simulation of a fire using a radiant heat source and a small-scale model are discussed. Means available for improving the reliability of assessment are suggested to include testing of simplified full scale models and mocked-up portions of casks to develop basic data relating to transient phenomena, testing of small scale models at 1475°F or other appropriate temperature to evaluate steady state conditions such as leak tightness of a closure at maximum expected temperature and pressure, and further development of calculational techniques for some items such as stresses from expansion of lead. (auth)

571 (CONF-681001–, pp 306-19) ASSESSMENT OF THE THERMAL BEHAVIOR OF IRRADIATED FUEL CASKS. Veith, K. H. (Bundesanstalt fuer Materialprufung, Berlin (West Germany)).

On the basis of the Schmidt–Binder procedure for solving unsteady-state heat transfer problems of infinite flat plates and infinite cylinders by graphical means, an analytical method for the assessment of the thermal behavior of casks by digital computer means has been developed. The procedure covers the evaluation of heat transfer by conduction, convection and/or radiation from the surroundings (fire or solar heat input) into the cask as well as the heat exchange between several layers of different materials within the cask construction. The results of tests performed on a simple model are compared with data evaluated by the analytical procedure. (auth)

572 (CONF-681001–, pp 320–43) EVALUATION OF TWO WOOD FIRE AND IMPACT SHIELDS. Lauer, R. J.; Seagren, R. D. (Oak Ridge National Lab., Tenn.).

A series of tests was conducted to determine the integrity of two wooden fire and impact shields. The original design was a simple wooden box (~2-in.-thick maple with a total wall thickness of ~4 in.) encased in a mild steel frame. All interior and exterior surfaces were painted with two coats of a rust-preventive paint. The redesigned shield was also a simple box, but two thicknesses of 1-in. fir plywood replaced the interior 2 in. of maple. Intumescent paint was applied between the two plywood surfaces, between the maple and plywood surfaces, and to the exterior surfaces of the maple. Mild steel strap was added to protect the surfaces which, in the first model, were found to be vulnerable to puncture. On the basis of drop and thermal tests conducted according to procedures outlined by the IAEA the second design of maple and plywood provides an adequate fire and impact shield; the original design failed the puncture resistance test. (auth)

573 (CONF-681001–, pp 344–53) DESIGN AND TESTING OF CURIUM SHIPPING CAPSULE AND CASK. Wilkins, C. A.; Kelsch, R. D.; King, F. D. R.; Stoddard, D. H.; Faraci, J. P.; Langhaar, J. W. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.).

A shipping capsule and cask were designed to transport curium oxide, recovered from irradiated reactor targets, from Savannah River Laboratory to Oak Ridge National Laboratory. The water-filled cask meets all specifications of the Atomic Energy Commission Manual, Chapter 0529 (impact, puncture, fire resistance, and biological shielding specifications). (auth)

574 (CONF-681001–, pp 354–72) DROP AND FIRE TESTS OF PACKAGINGS IN SWEDEN. Blomquist, R.; Jonasson, G. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

Tests on Type B packagings at the research establishment of AB Atomenergi in Studsvik are reported. Drop tests with a 7 ton cast model of SG iron and two wooden-insulated packagings for ion exchange resin and liquid radicactive waste respectively are described. An experimental study of the heat transfer between fire and packagings with outside cooling fins of different kinds is reported. Finally, a fire test of a wooden-insulated packaging partially filled with water is described. (auth)

575 (CONF-681001–, pp 373–98) STUDIES OF STRUCTURAL RESPONSE OF CASKS TO IMPACT. Clarke, H. G. Jr. (Franklin Inst. Research Labs., Philadelphia, Pa.).

The problem of crushing, rather than penetrating, impact of casks on flat essentially unyielding surfaces was studied experimentally by means of small, partial-cask models. Models of both cubic and cylindrical shape were tested with inner and outer shells of mild steel and shielding of chemical or antimonial lead. Outer shell thickness of these was varied. A few cylindrical models were included with a rounded bottom edge. In addition, two cylindrical models of all-steel construction were tested. Data were obtained on external deformation and reduction of shielding in the impacted region and on loss of volume of the inner cavity. Procedures are included for applying these model-generated data to the design of full-size casks. (auth)

576 (CONF-681001–, pp 399–409) CLASS I AND II PACKAGING CONCEPT FOR DRY LOW ENRICHMENT URANIUM OXIDE POWDERS. Gutman, Thomas (Westinghouse Electric Corp., Cheswick, Pa.).

A new UO_2 packaging concept has been developed by the Nuclear Fuel Division of the Westinghouse Electric Corporation and licensed by the U. S. Atomic Energy Commission and the Department of Transportation to permit shipment of large quantities of dry low-enriched uranium dioxide powder with minimal container handling and turn around time. The design features incorporated into this package should permit the shipper to load, and the receiver to unload a 17,000 pound UO_2 shipment in two to four hours. The package has an outside diameter of 24 inches, stands 75 inches high and has a tare weight of 300 pounds. As much as 240 pounds of UO_2 or U_3O_8 powder are placed into six high-strength water resistant cardboard drums measuring 9.5 inches diameter by 9.75 inches long. These are placed in a removable insert which is in turn placed into the inner container of the shipping package. This inner container is a leak-tight steel cylinder with a gasketed flange closure. Thermal and mechanical protection is provided by a fire-resistant insulator which separates the cylinder from the outer drum container. The drum lids are secured with bolts to permit closure from the top. Since horizontal access is not required, the packages need not be removed from the truck bed during loading or unloading. A lifting device engaging the insert, provides for removal of the contents, thus providing for minimal handling. In addition to reducing the time and expense of loading and unloading, this packaging concept should also minimize contamination of the outer packages, thereby also reducing the difficulty of routine decontamination. (auth)

577 (CONF-681001–, pp 410–25) FIBERBOARD-INSULATED CONTAINERS FOR SHIPPING FISSILE MATERIALS. Adcock, Frank E.; McCarthy, John D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.).

Department of Transportation (DOT) Specification 6M provides commercial and government organizations with a reliable, simple, and inexpensive package for shipping fissile and other radioactive materials. Variations in container sizes, materials, and construction are authorized, but the inside cavity must be limited to $5\frac{1}{4}$-inches diameter. A brief description and the nuclear safety calculations are given for Dow's Model 1518 which is the prototype of the Specification 6M Container. The Model 1518 has been used extensively during the last year with outstanding results. Protective overpacks for containment vessels up to 18-inches diameter have been designed and tested using fiberboard-insulated steel drums ranging in size up to 80-gallons. (auth)

578 (CONF-681001–, pp 426–37) NEW END-LOADING SHIPPING CONTAINER FOR UNIRRADIATED FUEL ASSEMBLIES. Mallett, A. J.; Newlon, C. E. (Oak Ridge Gaseous Diffusion Plant, Tenn.).

A new end-loading cylindrical shipping container, designed to meet Fissile Class I criteria, has been built for BONUS reactor fuel assemblies at ^{235}U enrichments to 3.95%. The container holds either six superheater assemblies or twelve boiler fuel assemblies. The high-temperature borated foam insulation, developed at the Oak Ridge Gaseous Diffusion Plant provides shock resistance and fire protection and reduces the nuclear reactivity of the package contents. (auth)

579 (CONF-681001–, pp 438–47) FAMILY OF SPECIAL NUCLEAR MATERIAL SHIPPING CONTAINERS. Kropp, R. E. (United Nuclear Corp., New Haven, Conn.).

With the adoption of the new AEC Transport Regulations for licensees, existing containers were surveyed for usefulness and a group selected for relicensing. These containers were then re-evaluated and submitted for relicensing. Concurrently, a group of new containers were being developed, tested and submitted for license approval. Examples of testing facilities are shown. (auth)

580 (CONF-681001–, pp 448–63) COMPUTER ANALYSIS OF THE CRITICALITY SAFETY OF SHIPPING CONTAINERS. Crume, E. C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).

The desirability and, in fact, near necessity of using reactor-theory-based computer programs in assessing the criticality safety of fissile material shipping containers is discussed with reference to the new shipping regulations for U.S.A.E.C. contractors. The computer programs ANISN, DOT, and KENO utilized in analyzing containers used and/or developed by the Oak Ridge Y-12 Plant are referenced. The analysis of a specific container, the Y-12 Foamglas Shipping Container Model FD for metal or dry solids containing ^{235}U as the only fissile radionuclide, is used to illustrate the applicability of the computer programs. Also, by comparing the results of the original analysis of that container, performed in 1963 with the results of a recently completed analysis, the benefits of using the more modern, more accurate computer programs for such analysis are exemplified. (auth)

581 (CONF-681001–, pp 464–76) DESIGN AND TESTING OF A LAMINATED STEEL PLATE CASK FOR THE TRANSPORTATION OF IRRADIATED FUEL BUNDLES. Taylor, W. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

A laminated steel plate cask was built to transport irradiated fuel about 1200 miles by rail or road between Chalk River Nuclear Laboratories and Whiteshell Nuclear Research Establishment. The packaging meets the IAEA "Regulations for the Safe Transport of Radioactive Materials" —1967 Edition. It is classified as Fissile Class II and Large Radioactive Source. The present shipping conditions for the fuel are: UC, UO_2 or Metallic U with

up to 2.5% weight ^{235}U; a maximum decay heat load of 1200 BTU/hr; and the fuel limits are $5\frac{3}{8}$ inches square by 41 inches long. Tests for impact resistance, leak tightness, fuel sheath temperatures and cask thermal equilibrium verified the cask integrity and design assumptions. The cask, test results and calculated temperatures during and after a fire are described. (auth)

582 (CONF-681001–, pp 477-86) TEST AND THEORETICAL ANALYSIS OF FIRE RESISTIVITY OF BETA-RAY THICKNESS GAUGE CONTAINERS. Moriya, Tadao (Fire Research Inst. of Japan, Tokyo).

Fire resistivity tests were carried out on the containers of beta ray thickness gauges now used in Japan which contain the beta-ray source capsules, the seal of which are considered to be weak against high temperature. The results obtained from the tests were analyzed. From this analysis a new source container can be designed whose source holder temperature will be controlled lower than the temperature of heat endurance limit of capsules under a fire condition. (auth)

583 (CONF-681001–, pp 487-500) SURVEY OF FISSILE MATERIAL SHIPPING CONTAINERS FOR BOTH NATIONAL AND INTERNATIONAL SHIPMENTS. Estes, B. F.; Barraclough, E. L.; Wood, D. P. (Albuquerque Operations Office (AEC), N. Mex.).

The wide range of activities under the cognizance of the Albuquerque Operations Office (ALO), U. S. Atomic Energy Commission, has created requirements for many types of containers for shipping fissile and radioactive materials, components, and wastes. The containers developed to satisfy these requirements are discussed including a brief description and methods of usage. (auth)

584 (CONF-681001–, pp 569-83) ALPHA, BETA, GAMMA TRANSPORT PACKAGINGS. Labrousse, M.; Bernard, H. (Commissariat a l'Energie Atomique, Paris (France)).

The appearance of breeder reactors will involve shipping of new and irradiated plutonium-based fuels. This element, which combines the disadvantages of being fissile, extremely toxic and an emitter of neutrons, and having very high residual power, poses difficult problems for the study groups in charge of packaging. In order to transport the still-small quantities required by present-day research reactors, the C.E.A. has developed two types of packages, described here, which precede those which will be used for power reactors. Emphasis is placed on systems used for avoiding contamination: joints with triple-effect lips, cold welds, as well as certain special features of γ shielding to stand up under dropping and fire tests. (auth)

585 (CONF-681001–, pp 584-606) DESIGN, ANALYSIS, AND FABRICATION OF SHIELDED CONTAINERS TO TRANSPORT HNPF FUEL ELEMENTS. Beaderstadt, Duane E.; Gower, George; Halpine, Paul A.; Miller, Harold N.; Owens, James E.; Ricci, Thomas (Division of Compliance (AEC), Washington, D. C.).

A review is presented of the Hallam Nuclear Power Facility (HNPF) spent fuel removal operation with emphasis on the development and design of shipping casks. The casks were designed to meet the revised requirements of USAEC Manual, Chapter 0529, dated August 22, 1966. (auth)

586 (CONF-681001–, pp 607-23) STRUCTURAL CONSIDERATIONS IN THE DESIGN OF THE HNPF SIX-ELEMENT IRRADIATED FUEL SHIPPING CASK. Jetter, R. I. (Atomics International, Canoga Park, Calif.).

A brief description is presented of the Hallam Nuclear Power Facility (HNPF) irradiated fuel shipping cask and details of the evaluation of the cask's response to the hypothetical accident sequence are discussed as well as the evaluation of possible cask distortion during the lead remelting operation. (auth)

587 (CONF-681001–, pp 624-36) DESIGN AND TESTING OF A SHIPPING CONTAINER FOR LARGE QUANTITIES OF RADIOACTIVE WASTE. Pearsall, S. G.; Majeski, S.; Gemmell, L. (Brookhaven National Lab., Upton, N. Y.).

Tests were conducted on containers in use for radioactive waste shipment to determine if these containers comply with new AEC regulations, namely Title 10 CFR 71, for the safe packaging and shipping of radioactive materials. At the Brookhaven National Laboratory, the concrete waste containers in present use were tested to determine their ability to meet the requirements of Appendix B of Part 71 Title 10, otherwise known as "hypothetical accident conditions." It was established that two of the three types in use had sufficient strength to withstand the drop test, while the third did not. The puncture test was simulated and it was proven that none of the present concrete containers would meet the puncture resistance requirements of Appendix B. Thus either a container made of a different material or a method of either strengthening or supplementing the existing design was necessary. A returnable steel outer protective container provided the best solution. This steel box, known as the "Brookhaven Overpack," is constructed of rectangular steel tubes welded to an inner steel plate to form a waterproof and durable shipping container. This was found to provide a protection against puncture, it would provide additional protection if dropped, and it has the advantage of being readily adaptable to many sizes and configurations of inner containers. (auth)

588 (CONF-681001–, pp 646-62) RELEASE OF RADIOACTIVE MATERIAL IN THE EVENT OF THE DESTRUCTION OF A FULL TYPE A PACKAGE. Hagsgard, S.; Johnson, S. F.; Jonasson, G.; Henriksson, S. (Aktiebolaget Atomenergi, Studsvik (Sweden)).

In the IAEA Regulations for the Safe Transport of Radioactive Materials the amounts of friable solid radioactive material permitted to be transported in a Type A package have been restricted on the basis of a hypothesis regarding the amount of material which could escape from the package damaged in a median accident. The results of an investigation to justify those assumptions are reported. The investigation can be divided into four phases. In the first phase, packagings were selected that could be approved as Type A using the tests prescribed in the IAEA regulations. Secondly the tests were made more severe in order to define a median accident, that is one that would cause some release but would not cause complete destruction of the package. In the third phase, packagings were designed which would just pass the Type A tests. In the fourth phase, these packagings were subjected to the tests defining the median accident and the fractions of the contents released were determined and compared with the assumptions. A number of already existing presumptive Type A packagings proved to be too strong to give release when subjected to conditions thinkable to simulate a median accident. However, a new packaging in the form of a simple plastic bottle was found to be suitable for the purpose. These packages were submitted to the Type A tests. Then about 10% failed which was supposed to be the criterion for just meeting the IAEA Type A requirements. It was found that the Type A penetration test extended to drops from 1.7 m was the only test suitable for simulating a median accident for this type of packaging. In this test release of activity occurred in about 90% of the cases and the mean value of the fraction of activity released was found to be 0.76×10^{-3}, with a standard deviation of $\pm 0.46 \times 10^{-3}$. Errors in these experimental values are discussed. The conclusion of the investigation is that the Type A packaging tests prescribed in the IAEA Transport Regulations are suitable for their purpose, that many of the today commonly used Type A packagings would be able to pass more severe tests, and that the fractional release in a median accident from a package which will just pass the Type A tests compares favorably with the hypothetical value of 10^{-3} assumed in the IAEA Safety Series No. 7 as the escape from Type A package in a median accident. This hypothetical value is therefore a reasonable assumption for packages containing friable solid radioactive material. (auth)

589 (CONF-681001–, pp 663-72) 30 TON CASK FOR SHIPMENT OF PWR-BWR FUEL. Aupetit, Armand; Blum, Paul (Societe Lyonnaise de Plomberie Industrielle (France)).

For shipping spent fuel elements from 8 or 9 light water power reactors of the first generation built in continental Europe, 30-ton casks have been designed and fabricated. The reasons for choosing the 30-ton weight, the problems involved, and some technical solutions are discussed. (auth)

590 (CONF-681001–, pp 673-90) ANALYSIS OF THE STRUCTURAL RESPONSE OF A CASK TO A FIRE ENVIRONMENT. Doshi, K. D. (Whittaker Corp., San Diego, Calif.).

The structural response of a cask to a fire environment is analyzed. Starting with a discussion of the various stages of container response, a procedure is described for evaluating the pressure generated in the molten shield region of the cask. Only the stages following the melting of the outermost layer of shielding are considered. In the analysis, the possibility of the outer/inner shells warping is avoided by assuming axially symmetric temperature distribution within the container body. The procedure is quite general otherwise, and can be used for both prismatic and cylindrical geometries and for any shield material with 3-layer construction of the container wall. The procedure presented provides a starting point for further analytical and experimental studies of the problem. (auth)

591 (IDO–12040(Suppl.3)) RADIOACTIVE WASTE DISPOSAL DATA FOR THE NATIONAL REACTOR TESTING STATION, IDAHO. Osloond, Joe H.; Newcomb, D. L. (Idaho Operations Office (AEC), Idaho Falls. Health Services Lab.). Oct. 1968. 14p. Dep. CFSTI.

Data on radioactive waste associated with reactor operations or research studies at the National Reactor Testing Station during 1967 are presented. The radioactive wastes are identified according to quantity, physical form, nuclide content, and the installation or area originating the waste. Radioactive waste data for the years 1955 through 1966 are also given in summary form. A more detailed presentation of disposal data for years prior to 1967 is available in reports IDO-12040 and IDO-12040 Supplement No. 1 and No. 2. (auth)

592 (LA-DC-10004) GROUND DISPOSAL OF LIQUIDS. Christenson, C. W. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 11p. Dep. CFSTI.

From Basic Training Course in Management of Radioactive Wastes, IAEA-Brazil CNEN, Rio de Janeiro, Oct. 14-25, 1968. radioactive wastes 18G

The disposal of liquid radioactive wastes to the ground is discussed as part of a basic course in radioactive waste management given in Rio de Janeiro, Oct. 14 to 25, 1968. The factors which determine the feasibility of ground disposal, namely, the climate, geology, and hydrology of the disposal site, the composition of the waste solution, and the methods of disposal are explained. (L.C.L.)

593 (ORNL-4272, pp 249-55) SAFETY STUDIES OF FUEL TRANSPORT. (Oak Ridge National Lab., Tenn.).

Developments in criteria for establishing suitable engineering standards for the design, fabrication, and inspection of irradiated fuel shipping casks by providing information on structural integrity, shielding, heat transfer, criticality, materials of construction, and fabrication techniques are described. AEC cask projects are briefly described. The Chemical Technology Division is in the process of analyzing all its casks to determine what modifications, if any, will be required to meet the regulations of the AEC and the new Department of Transportation (DOT). One new design has been approved by the AEC and DOT. (P.C.H.)

594 (ORNL-TM-2220) ANALYSIS OF THE OAK RIDGE NATIONAL LABORATORY SHIPPING CASK D-38. Evans, J. H. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 58p. Dep. CFSTI.

An analytical evaluation of the ORNL Shipping Cask D-38 was made to demonstrate its compliance with the regulations governing packages in which radioactive material is shipped. Computational procedures were used to determine the structural integrity and thermal behavior of the cask with respect to the general standards for packaging, structural standards, standards for normal conditions of transport, and the standards for the hypothetical accident conditions. The results of this evaluation show that the cask complies with all the applicable regulations. (auth)

595 RADIATION PROTECTION FOR SAFE HANDLING OF ^{252}Cf SOURCES. Wright, C. N. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 15: 466-9(Nov. 1968).

Californium-252 may be used extensively in the future as a neutron source; some of the characteristics of such sources are reviewed from the health physics viewpoint. Neutron and gamma ray dose-equivalent rates from a microgram of ^{252}Cf in air are shown graphically, and formulae for predicting dose rates in air are given. Not only are dose rates from ^{252}Cf higher than from therapeutically equivalent amounts of radium, but shielding and storage problems are different; some shield attenuation characteristics are shown for lead and polyethylene. Since the average neutron energy of these sources (2.34 MeV) is considerably lower than from PuBe or PoBe sources, a large percentage of the neutrons may be reduced in the shield to energies below the detection threshold of fast neutron survey meters, and hence estimated doses may be erroneously low. Suitable survey instruments are recommended. (UK)

596 LARGE SCALE EXPLOITATION OF FISSION PRODUCT RHODIUM AND PALLADIUM. Rohrmann, C. A. (Battelle Memorial Inst., Richland, Wash.). Engelhard Ind., Tech. Bull., 9: 56-61(Sept. 1968).

Rhodium and palladium are among those elements produced in highest yield in the fission process, particularly in the fission of plutonium. The anticipated growth of the atomic power industry is at such a rate that within ten years the discharge of wastes from the chemical processing of spent fuels from U.S. power reactors will contain more rhodium than is now supplied annually to American industry from conventional mineral sources. A similar situation should exist for palladium before the turn of the century. In addition these metals are produced with a very low concentration of objectionable radioactive isotopes of rhodium and palladium. The residual activity, which is known to be present, is expected to be low enough to permit application of these elements to the important, well known, large scale applications. The large scale exploitation of these elements from this new (and until recently nonexistent) source affords the means by which an ever growing supply of these precious metals will be at hand to serve mankind's essential needs such as, for example, food production and communications. (auth)

597 SHOCK RESISTANCE OF FERRO-CONCRETE VESSELS USED FOR OCEANOGRAPHIC RADIOACTIVE-WASTE DISPOSAL. Akazuka, Yuzo; Seki, Hiroshi (Technical Research Inst., Ministry of Transportation, Japan). Semento Konkurito, No. 252, 41-50(Feb. 1968). (In Japanese).

The results of drop tests performed in the Port and Harbour Research Institute on the shock resistance of concrete vessels are reported. The shock resistance was studied by measuring the stresses occurring at the time of a drop impact and observing the cracks on the vessel surface. Descriptions are given of the requirements for ferro-concrete vessels, drop and pressure tests, design of ferro-concrete vessels, dropping test procedure, characteristics of the shock-waves, impact force and strain, and, shock resistance of ferro-concrete vessels. (NSA of Japan)

598 CATION EXCHANGE CAPACITY OF KIRDZHALI CONCRETES FOR DECONTAMINATION OF RACIOACTIVE WASTES. Pavlov, I.; Troshev, T.; Zhelyazkov, V. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 637-9(1968). (In Russian).

Tests carried out with various green and white concretes in order to determine their ion exchange capacity for strontium showed that Kirdzhali green concrete has the highest ion-exchange level and can be used most effectively as a sorbent for the decontamination of liquid radioactive wastes. (R.V.J.)

599 FLUID DISTRIBUTING APPARATUS. Gronlund, Kaj Anders (to Aktiebolaget Atomenergi). British Patent 1,131,844. Oct. 30, 1968. Priority date Nov. 6, 1964, Sweden.

A fluid distribution apparatus which can measure and distribute predetermined quantities of liquids or gases, especially radioactive fluids, is described. (B.G.D.)

600 PNEUMATIC BURETTE FOR REMOTE WORK WITH HIGHLY RADIOACTIVE SOLUTIONS. Sentyurin, I. G.; Sklyarenko, I. S. At. Energ. (USSR), 25: 325-6(Oct. 1968). (In Russian).

The design and operation of a pneumatic burette for remote control measurements of radioactive materials separated into a large number of samples and for their titration are described. (R.V.J.)

601 CONTAINER CLOSURE SYSTEM. Mansard, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,132,569. Nov. 6, 1968. Priority date Jan. 4, 1967, France.

A container with a leak-tight closure designed primarily for transporting and storage of radioactive samples is described. The cylindrical container has a chamber found inside with an opening which is defined by a frusto-conical bearing surface, a plug fitted with a seal which is applied to the bearing surface, and a rotating locking member mounted on the plug. (F.S.)

602 APPARATUS FOR HANDLING OBJECTS IN A GLOVE COMPARTMENT. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,133,494. Nov. 13, 1968. Priority date June 18, 1965, Germany.

An apparatus is described which is used in manipulating objects contained in a glove box. An elastic arrangement allows the hand to be inserted and withdrawn from the box with greater ease. The elastic arrangement is responsive to the force of the hand inserted in the glove. (F.S.)

Vacuum Engineering

603 (N-68-29460) DEVELOPMENT OF ELECTRICAL SWITCHGEAR FOR SPACE NUCLEAR ELECTRICAL SYSTEMS. Powell, A. H. (ed.) (General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section). July 1968. Contract NAS3-6467. 119p. (NASA-CR-1026; R-67-SD-3012). CFSTI.

High capacity circuit breakers and contactors are needed for future large spacecraft systems with 500 to 1000 kW(e) power supplies. Based on the latest experience on utility and industrial systems, a vacuum interrupter appears to be the simplest means of obtaining suitable performance in a space environment. The feasibility of power interruption in a vacuum capsule in a space environment of 1000°F ambient temperature had been previously investigated, and with this background, preflight prototype single pole breakers and contactors have now been designed, built, and extensively tested. The breaker, rated 1000 volts, 600 amperes, 2000 cps, for main system protection, and the contactor, rated 10,000 volts, 10 amperes, for propulsion engine switching, have been mechanically and electrically tested. Overall performance has been determined in a preliminary way, and successful completion of 1000-hour endurance test in the 1000°F and 10^{-6} (or lower) torr pressure has given confirmation of the feasibility of the vacuum switchgear for large space systems. (STAR)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 424 and 459.

General Detectors and Monitors

Refer also to abstracts 722, 726, 728, 746, 1580, 1825, 2042, and 2046.

604 (ACRH-1000-68) THE COMPARISON BETWEEN SENSITIVITY AND RESOLUTION BASED ON A CLINICAL EVALUATION WITH THE ACRH BRAIN SCANNER. Gottschalk, A.; Abatie, J. D.; Petasnick, J. P.; Polcyn, R. E.; Beck, R. N.; Charleston, D. B. (Chicago Univ., Ill. Dept. of Radiology. Argonne Cancer Research Hospital, Chicago, Ill.). Aug. 15, 1968. Contract AT(11-1)-69. 18p. (CONF-680804-4). Dep. CFSTI.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

A series of 85 proven brain tumors scanned on the ACRH brain scanner was analyzed to see if cases scanned with high resolution collimators were detected more often than cases scanned with lower resolution collimators. In addition, since both collimators had an equal or better resolution than a commercial brain scan collimator for a 7.5 cm diameter crystal, the entire series was compared with the results of other investigators using this type of detector. The data show that detection rate was not increased by using high resolution brain scans. (auth)

605 (ACRH-1000-72) EVALUATION OF SCANNING PROCEDURES IN TERMS OF INFORMATION THEORY. Harper, P. V.; Beck, R. N.; Cohen, T. D. (Argonne Cancer Research Hospital, Chicago, Ill.). Aug. 15, 1968. Contract AT(11-1)-69. 20p. (CONF-680804-2). Dep. CFSTI.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

A partial criterion is proposed for radioisotope imaging system performance based on considerations of information theory which appear to correlate qualitatively and quantitatively, at least in simpler tests, with perceptual observations, and which appear to be amenable to extension into detailed analysis of many problems in scanning. A general conclusion appears to be that assessment of the performance of an imaging system requires detailed specifications of the object, the amount of radiation to be detected and the questions to be asked of the system. With these parameters specified, a concise mathematical formulation is presented which appears to conform to the intuitive notions associated with radioisotope scanning. Although the criterion presented appears necessary for imaging, it is not sufficient, and does not permit definition of the optimal conditions for perception which appear to depend on additional parameters concerned with image processing and viewing. (auth)

606 (ACRH-1000-79) EFFECTS OF SCATTERED RADIATION ON SCINTILLATION DETECTOR RESPONSE. Beck, R. N.; Schuh, M. W.; Cohen, T. D.; Lembares, N. (Argonne Cancer Research Hospital, Chicago, Ill.). Aug. 15, 1968. Contract AT(11-1)-69. 31p. (CONF-680804-3). Dep. CFSTI.

From Symposium on Medical Radioisotope Scintigraphy, Salzburg, Austria.

A complete analysis of the response of a collimated scintillation detector to an in vivo distribution of radioactivity must include the responses to both unscattered γ-rays and the continuous spectrum of photons with reduced energy, produced by Compton interactions in the tissue. The amount of scattered radiation entering the detector is a function of the γ-ray energy, the distribution of radioactivity in the tissue, and the tissue attenuation coefficient. The ratio of responses to scattered and unscattered photons, called the scatter fraction, S, is also a function of the energy resolution of the scintillation detector, and the base line setting, E_B, of the pulse height analyzer. To evaluate S as a function of E_B, it is necessary to know the shape of the scatter spectrum within the unscattered photopeak region. Smoothed scatter spectra were computed for four γ-energies in the range of 140 to 511 keV by smoothing the Klein-Nishina equation for the energy spectrum of scattered photons. In each case the amplitude of the smoothed scatter spectrum is normalized to, and subtracted from, the pulse amplitude spectrum observed for a brain phantom to obtain the photopeak due to unscattered γ-rays, and a measure of S vs. E_B. The effects of scattered radiation on the detector sensitivity, line spread function, and modulation transfer function (MTF) are evaluated. In general, sensitivity is decreased and spatial resolution is improved as E_B is increased. When the statistical figure of merit (which is proportional to the product of the sensitivity and the MTF^2) is used as a criterion of system quality, an optimum base line setting can be found for specific application. For brain scanning with γ-ray emitters in the energy range of 140 to 511 keV, the optimum window setting almost precisely brackets the unscattered photopeak. It is shown that the response to complex objects in a scattering medium can be computed from the line spread function or the modulation transfer function. (auth)

607 (AD-671610) DEVELOPMENT OF FERROELECTRIC NUCLEAR RADIATION DETECTORS. [Progress] Report No. 1, June 1966-October 1967. Glower, D. D.; Miller, D. W.; Schlosser, P. S. (Ohio State Univ. Research Foundation, Columbus). June 1968. Contract DA-18-035-AMC-952(A). 72p. (NDL-TR-110). CFSTI.

Nuclear radiation detectors utilizing the pyroelectric effect of a ferroelectric material, specifically, lead zirconate titanate (PZT), have been developed. The detectors are rate measuring devices with a sensitivity of 0.6 pC/cm sq-Rad (PZT). The analyses of the theory, design, and experiments, as presented, demonstrate that the ferroelectric radiation detector system can be fabricated to measure gamma and x-ray energy spectra for a single radiation pulse and that this detector system can evaluate the time-dependence of these spectra. Further, it has been demonstrated that these detection systems are small in size, require a minimum of support equipment such as bias voltage power supplies, and provide instantaneous readout of the data. Experiments have demonstrated the reproducibility of data and linear response to dose rates greater than 10 to the 12th power Rad/sec. (auth) (USGRDR)

608 (BNWL-SA-1976(Rev.)) SPECTRAL DATA HANDLING SYSTEMS. Brauer, F. P.; Schlosser, J. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 26p. (CONF-681003-7). Dep. CFSTI.

From International Conference on Modern Trends in Activation Analysis, Gaithersburg, Md.

Gamma-ray spectrometry is frequently used to identify and estimate radionuclides in neutron activated samples. Spectra observed at different times after neutron exposure are often accumulated on a single sample in order to obtain half-life as well as energy information, and thus estimate both long and short-lived nuclides. The use of multidimensional NaI(Tl) detector configurations or Ge(Li) detectors can result in up to 4000-channel spectra. The quantity and complexity of the data is further increased when the laboratory has a variety of different detector systems and analytical requirements. Electronic data processing techniques can be used to handle the large data volumes associated with modern instrumental activation analysis, and are essential in some multiplex analyzer configurations. Several data processing systems utilizing large digital computing center facilities have been developed by our laboratory for the assembly of spectra files, analysis of the spectra, and storage and retrieval of the analytical results. (auth)

609 (CEA-R-3319) STUDY OF A HIGH SURFACE GAS TRIODE FOR DETECTING ATOMIC OR NUCLEAR PARTICLES. Lansiart, Alain (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 79p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

A triode filled with xenon at atmospheric pressure can be used as an x-ray detector since it produces an appreciable amount of light per quantum absorbed. Various methods are described for studying and reducing the deadtime after the passage of a spark. This detector can be used in medicine for the detection of tumors and also for the rapid recording of diffraction diagrams. (auth)

610 (CEA-R-3532) DESCRIPTION OF METHODS FOR MAKING ACTIVATION DETECTORS FOR USE IN NUCLEAR REACTORS. Barbalat, Rene; Le Coguie, Roland; Leger, Pierre; Salon, Lucien; Thierry, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1968. 79p. (In French). Dep.

A brief description of methods currently used for making activation detectors, thin films, and various deposits used in nuclear reactors. The thicknesses required vary from about a few tenths of a micron to a few tenths of a millimeter. Different techniques are used for fixing the large variety of elements: rolling, moulding, painting, electrolysis, vacuum deposition, thin films, wires, enamels, protective linings, etc. (auth)

611 (CEA-R-3584) WEAK CURRENT MEASUREMENT. APPLICATION TO THE DETERMINATION OF EXPOSURE DOSES. Lagoutine, Frederic (Commissariat a l'Energie Atomique,

Saclay (France). Centre d'Etudes Nucleaires). Sept. 1968. 15p. (In French). Dep.

A method for the absolute measurement of weak currents produced in an ionization chamber is described. The measuring assembly consists basically of cavity ionization chambers connected to an electrometric device. When used to measure exposure dose rates, this apparatus can cover a range from 10 milliroentgens/hour to 15,000 roentgens/hour. (auth)

612 (KFKI-27/1968) THIN-CRYSTAL MOSAIC DETECTOR FOR IN VIVO MEASUREMENTS. Andrasi, A.; Feher, I.; Lendvay, J. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Oct. 1, 1968. 10p. Dep.

Investigations of a thin crystal mosaic detector of 400 cm^2 sensitive surface, developed for the human in vivo counting of low energy photons, are reported. The characteristic data of the equipment, resolving power, counting efficiency, and background were measured. The counting efficiency of the mosaic detector for activities deposited in the lung was evaluated on computer using a simple mathematical model which was utilized also for the comparison of the mosaic detector efficiency with that of the earlier used low energy photon detectors. The computer results were checked by a measurement on point source. The design of a possible scanning bed and 4π counter equipment containing several mosaic detectors is discussed. A model measurement is described which has been performed, assuming a ring of 6 mosaic detectors, to evaluate the sensitivity and minimum detectable amount for some important isotopes in the case of multidetector equipments. (auth)

613 IMAGE QUALITY OF A GAMMA CAMERA SYSTEM. Svedberg, John B. (Uppsala Univ.). Phys. Med. Biol., 13: 597-610(Oct. 1968).

Computer calculations were made to study the image quality with respect to co-ordinate distortion of gamma camera systems of the Anger type as a function of the design parameters: crystal dimensions, light guide length and optical properties, number, size and position of the photomultiplier tubes, and types of pulse mixing circuit. The use of ratio circuits, in which the denominator pulse and the energy defining pulse are generated separately, was found to improve the image quality considerably. (auth) (UK)

614 THE MEASUREMENT OF LOW ENERGY X-RAYS. IV. TOTAL ABSORPTION IONIZATION CHAMBER. Greening, J. R.; Randle, K. J.; Redpath, A. T. (Royal Infirmary, Edinburgh). Phys. Med. Biol., 13: 635-42(Oct. 1968).

An ionization chamber operated at pressures of up to 3 atmospheres of argon was used to measure energy fluence by totally absorbing various x-ray beams generated between 10 and 30 kV. Comparison of the response of a total absorption calorimeter with that of the ionization chamber indicated that the average energy required to form an ion pair in argon is 26.36 ± 0.17 eV, with no significant variation over the energy range investigated. The saturation of the ionization chamber was investigated, and attention is drawn to its precision and sensitivity. (auth) (UK)

615 ABSOLUTE INTENSITY CALIBRATION OF A GRAZING-INCIDENCE SPECTROGRAPH IN THE WAVELENGTH REGION 10 TO 120 A. Morgan, F. J.; Gabriel, A. H.; Barton, M. J. (Culham Lab., Abingdon, Eng.). J. Phys., E (London), 1: 998-1002(Oct. 1968).

A method is described for determining the absolute sensitivity of a grazing-incidence spectrograph. This makes use of an x-ray source of discrete K-lines, the intensity of which is monitored by a flow proportional counter, acting as an absolute photon flux detector. Experimental results are given for Ilford Q2 emulsion used with a two-metre 600 lines per mm platinum-coated blazed grating at an angle of incidence of 88°. The resultant curve compares well with a relative calibration obtained by using the radiation from a 335-MeV electron beam in a synchrotron. (auth) (UK)

616 URANIUM AND BORON CONTENT OF WATER BY PARTICLE TRACK ETCHING. Fleischer, R. L. (California Inst. of Tech., Pasadena); Lovett, D. B. Geochim. Cosmochim. Acta, 32: 1126-8(Oct. 1968).

Track activation techniques make the measurement of the content of specific impurities in water particularly simple. By choosing detectors of the proper sensitivities, elements giving (n,f) reactions, such as uranium and plutonium, and those giving (n,α) reactions, such as boron and lithium, can be determined. (auth) (UK)

617 APPLICATION OF ANALYSIS OF VARIANCE TO TEST FOR COUNTER STABILITY. Cember, H. (Northwestern Univ., Evanston, Ill.). Health Phys., 15: 471(Nov. 1968).

Comments are offered on the application of statistical treatments to counting data. A simple statistical technique which is widely used in the treatment of experimental data, and which is also applicable to the analysis of radioactivity measurements, is the one-way analysis of variance. This method was found to be a very useful and sensitive technique for determining small changes in counting systems that would otherwise have escaped unnoticed, and a specific case is described. (UK)

618 HIGH FLOW-RATE CALORIMETER FOR ION BEAM INTENSITY MEASUREMENTS. Hara, E. (Hitachi Central Research Lab., Tokyo). J. Phys., E (London), 1: 1032(Oct. 1968).

The flow-type calorimeter is one of the most widely utilized means of measuring high-intensity ion beams. It was found, however, that if the coolant flow was not turbulent, it could give erroneous results, due to considerable radiation loss and increase of the secondary electron emission coefficient produced by a large temperature rise of the target surface. (auth) (UK)

619 APPLICATION OF SOLID STATE DETECTORS TO ENVIRONMENTAL AND BIOLOGICAL PROBLEMS. Cooper, J. A.; Wogman, N. A.; Palmer, H. E.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 15: 419-33(Nov. 1968).

The applicability of the new high-resolution semiconductor detectors to the direct instrumental analysis of several complex mixtures of radionuclides was demonstrated. Samples investigated included environmental and biological materials containing radionuclides from nuclear weapons testing, atmospheric spallation reactions, emanation gases, etc., and neutron activated samples used in the determination of trace element concentrations. It was shown that the increased selectivity of the semiconductor detectors allowed a much more precise analysis of most of the constituents than is possible with conventional NaI(Tl) spectrometry. It was also shown that for some radionuclides the sensitivity of the semiconductor detector is even greater than highly selective NaI(Tl) multidimensional spectrometers. (auth) (UK)

620 POSSIBILITIES OF THREE-DIMENSIONAL SCINTIGRAPHY WITH A γ-γ CASCADE. Feuerhake, Inge (Medizinische Hochschule, Hanover). Atompraxis, 14: 405-7(Sept.-Oct. 1968). (In German).

With the aid of the coincidence principle, a true layer scintigram was made, using the γ-cascade isotope Se-75. The equipment consisted of a conventional scanner and additional detectors with large plastic scintillators and slit collimators, together with suitable coincidence electronics. The sensitivity attained in the preliminary experiments indicates that the method has promise for certain practical problems, as soon as sufficient cascade isotopes, e.g., In-111, are available on the European market. (auth)

621 ERROR STATISTICS OF ACTIVITY MEASUREMENTS WITH STANDARDS. Plesch, R. (Siemens AG, Karlsruhe, Ger.). Atompraxis, 14: 409-15(Sept.-Oct. 1968). (In German).

Former considerations of the error statistics of activity measurements did not allow for the a priori-error of the activity standard and the statistical error of the standard pulse rate because of the insignificance of these errors. But they can reach in some cases such a magnitude, that they are not to be neglected furthermore. In this paper, the statistical error of the sample activity, the smallest difference between two samples to be measured and the limit of indicating are treated including the errors caused by the application of a standard. Subsequently, the minimizing of the above mentioned statistical terms by choicing suitable measuring times is represented. From this, rules of selection of measuring devices are given. The formal connections are illustrated by numerical examples. (auth)

622 LOW LEVEL MEASUREMENT WITH SURFACE BARRIER DETECTORS. Kuhn, L. (Frieseke and Haepfner GmbH, Erlangen, Ger.). Atompraxis, 14: 389-91(Sept.-Oct. 1968). (In German).

The application of surface barrier detectors for low level β-measurement is limited by use of the figure of merit E^2/n_0. The most important properties of surface barrier detectors with regard to low level measurements are indicated. While the high energy resolution of the detectors can be used for α- and γ-measurements, the noise of the surface barrier detectors constitutes a lower limit for β-measurements. A connection between noise and β-detection limit will be indicated. Finally a survey is given on the composition of the background of surface barrier detectors. (auth)

623 WINDOWLESS MEASUREMENT OF COUNTING RATE AT LIQUID SCINTILLATION COUNTING. Kaczmarczyk, N.; Ruge, I. (Technische Hochschule, Muinch). Atompraxis, 14: 391-3(Sept.-Oct. 1968). (In German).

At liquid scintillation counting the activities of β-emitters are usually measured at the balance point. It is experimentally shown that for greater counting rates (n_p > 75 cpm) the windowless mea-

surement (i.e., setting without upper discriminator) is more accurate than the balance point operation. Although the background increases, the statistical goodness of a windowless measurement is greater. (auth)

624 COUNTING ^{3}H-, ^{14}C-, AND ^{32}P-RADIOACTIVITY IN AQUEOUS SOLUTION BY THE FLOW-THROUGH SCINTILLATION METHOD. Hoelzel, F.; Wiegers, U.; Kuhweide, U. (Univ., Hamburg). Atompraxis, 14: 394-7(Sept.-Oct. 1968). (In German).

The absolute and the operating efficiency of ^{3}H, ^{14}C, and ^{32}P was determined in a flow-through scintillation system with various scintillators (anthracene, plastic scintillator spheres, pilot-B-beads and glass scintillator powder). The rate of adsorption of some nucleosides, amino acids and of ^{32}P-PO_4 was tested. ^{32}P-labelled, high molecular weight ribonucleic acid was adsorbed to anthracene at a high degree. No adsorption of RNA was found with the tested plastic scintillators. (auth)

625 LIQUID SCINTILLATION COUNTING OF THORIUM, PROTACTINIUM, AND NEPTUNIUM. AVOIDANCE OF QUENCHING CAUSED BY ABSORPTION ON THE WALL. Ihle, H.; Karayannis, M.; Murrenhoff, A. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 14: 397-402(Sept.-Oct. 1968). (In German).

The method of internal liquid scintillation counting with stabilization of the solution of the radionuclide in the liquid scintillator by means of tri-n-octylphosphine oxide or polyvinylchlorideacetate-copolymer has been successful for U, Pu, Am, Cm, and other radionuclides in routine counting as well as in high precision absolute counting. The applicability of this method to nuclides of the elements Th, Pa, and Np has been experimentally investigated. (auth)

626 CALIBRATION OF A HIGH-SENSITIVITY LARGE AREA WHOLE-BODY COUNTER. Barnaby, C. F.; Jasani, B. M. (University Coll. Hospital, London). Phys. Med. Biol., 13: 561-72(Oct. 1968).

The whole-body counter considered is based on a design which uses total internal reflection as the method of light collection. It is shown that a calibration curve in which the response of the counter is plotted as a function of weight is adequate over a wide range of patient size. The results are compared with those obtained with a whole-body counter based on the cylindrical design, and it is shown that the calibration of the two types of counter is similar. (auth) (UK)

627 FAST COINCIDENCE–ANTICOINCIDENCE SYSTEM IN A SATELLITE EXPERIMENT. von Ellen, H.; Mueller, K. (AEG-Telefunken, Ulm, Ger.). Atomwirtschaft, 13: 488-90 (Oct. 1968). (In German).

Gamma-ray astronomy has gained increasing significance during recent years. The MIMOSA Group, an association of scientists from Milan University, the MPI for Extra-terrestrial Physics in Munich-Garching and the CEN Saclay, are at the present time preparing an experiment to measure cosmic gamma rays which is to be flown in the TD-1 satellite of the ESRO. The measurement of the direction and energy of gamma quanta is carried out using a spark chamber with scattering plates. In the chamber a gamma quantum is converted with a high probability into an electron-positron pair whose paths supply the desired information about the direction and energy of the quantum. The measurements will cover the energy range of 10 to 100 MeV. The expected gamma quanta will be submerged in a very strong flux of background radiation consisting essentially of protons. Under unfavorable conditions the background radiation produces about 10^6 times more numerous charged carrier traces in the spark chamber than are created by the gamma quanta. An arrangement consisting of an anticoincidence counter, a two body counter and a Cherenkov counter serves to select the gamma quanta from the background radiation. The spark chamber is only triggered—and the charged particle traces made visible—when the two-body counter indicates the passage of two minimum ionizing particles and the Cherenkov counter signals the passage of one particle, the anticoincidence counter on the other hand giving no signal. Application of voltage to the spark chamber should be complete within 100 nanosecs of the passage of a particle—in the case of a favorable event. The development of the electronics was made extremely difficult because only 1 W of power was available. (auth)

628 STABILIZATION OF CONDITIONS OF WORK OF SELF-QUENCHING G–M COUNTERS. Karatoteva, T.; Peeva, A. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 21: 629-32(1968).

The stability of the operating characteristics of self-quenching Geiger–Mueller counters was investigated. The characteristics were length, counting rate, and slope of plateau. The characteristics were examined with counters of approximately equal geometry, with different cathode and anode materials, and different gas mixtures but the same total pressure and same gas ratio. (B.G.D.)

629 RANDOM-DRIFT SAMPLING: A STUDY BY COMPUTER SIMULATION. Lehman, R. L.; Brisbane, R. W. (Univ. of California School of Medicine, Los Angeles). Nucl. Instrum. Methods, 64: 269-77(Oct. 1968).

Bias introduced by a continuous-drift sampling method for selecting and measuring tracks in nuclear emulsion was evaluated by computer simulation. The sample distributions drawn from population types and densities that are of possible interest to neutron spectroscopy were compared with expected distributions by χ^2, sign and sum, and spacing distribution tests. The results indicate that the random-drift method provides samples that closely approximate in general shape and in slope the populations from which they are drawn. In addition, the bounds and limits of random-drift sampling domains, and the number of tracks sampled per 2.5 cm pass, are given for certain distributions pertinent to fast neutron spectroscopy. (auth)

630 HIGH-RESOLUTION STUDY OF LOW-ENERGY HEAVY COSMIC RAYS WITH LEXAN TRACK DETECTORS. Price, P. B. (General Electric Research and Development Center, Schenectady, N. Y.); Fleischer, R. L.; Peterson, D. D.; O'Ceallaigh, C.; O'Sullivan, D.; Thompson, A. Phys. Rev. Lett., 21: 630-3(Aug. 26, 1968).

The response (track-etching rate) of Lexan polycarbonate detectors increases exponentially with the ionization rate of heavy nuclei ($Z \geq 10$). These detectors have been used to measure the charge composition and flux in 1967 of low-energy (200- to 400-MeV/nucleon) cosmic rays from $12 \leq Z \leq 28$. (auth)

631 SHAPE OF PULSES GENERATED BY ALPHA-PARTICLES IN SILICON DRIFTED DETECTORS. Moszynski, M.; Przyborski, W. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Instrum. Methods, 64: 244-50(Oct. 1968).

The results of investigations of the shape of pulses generated by α-particles in silicon drifted detectors having an active area 0.7 to 2.4 mm thick, under room and liquid nitrogen temperatures are presented. It has been found, by fitting the analytical form of the pulse to an experimental shape, that the electric field distribution in such a detector is a parabolic function of depth. The distribution of concentration of donor impurities has been determined. Pulse risetimes have been determined as a function of the average value of the electric field and the thickness of the detector active area. Some information has also been obtained about the influence of short-term trapping on the process of charge collection. (auth)

632 RESOLUTION OF GRAPHITE STRUCTURE DURING MICROAUTORADIOGRAPHY. Bunnell, L. R. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Rev. Sci. Instrum., 39: 1763-4(Nov. 1968).

A microautoradiographical method for distinguishing particle tracks from the low reflectance, complex graphite structure during the autoradiographical analysis of radioactive materials in graphite is described. (W.H.K.)

633 GUARD RING SHIELDING TO ELIMINATE INSTABILITY OF COLLECTING VOLUME IN IONIZATION CHAMBERS. Attix, F. H.; Gorbics, S. G. (Naval Research Lab., Washington, D. C.). Rev. Sci. Instrum., 39: 1766-7(Nov. 1968).

A stability problem encountered in the use of a variable length, free air chamber for x-ray exposure standardization is discussed, and a design modification is described to correct the instability. (W.H.K.)

634 UNIFORMITY OF RESPONSE FROM LARGE AREA PLASTIC SCINTILLATION DETECTORS. Gillespie, C. R. (Louisiana State Univ., Baton Rouge). Rev. Sci. Instrum., 39: 1724-7(Nov. 1968).

Using only two 8055 photomultipliers and no light pipes, photomultiplier geometries were found which gave rather uniform response over 1.7 m^2 surfaces of single and double sheets of 2.5 cm thick Pilot Y plastic scintillator. The detector response obtained had a standard deviation from the mean of 2.8% for single sheets of Pilot Y scintillator and 3.7% for double sheets. (auth)

635 AUTOMATIC DRUM SCANNING SYSTEM FOR THE MEASUREMENT OF PLUTONIUM IN WASTE. Cole, H. A. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 65: 45-57(Oct. 15, 1968).

A method is described for locating and estimating the plutonium content of waste drums, without the need for opening the drums. The method relies upon the measurement of the 384 keV γ-radiation from ^{239}Pu and uses a simple form of γ-spectrometer and a drum scanner. The detection sensitivity enables the measurement of plutonium within the range 22 mg–20 g, with a measurement accuracy of 4–30%, depending upon the nature of the waste present in the drums and the ability to correct for self absorption and interfering radiation. (auth)

636 MULTIDECADE HYBRID RADIATION SURVEY METER. Nirschl, J. C.; Healey, G. F. (Army Electronics Command, Fort Monmouth, N. J.). Nucl. Instrum. Methods, 65: 61-71 (Oct. 15, 1968).

The design of a radiation survey meter is described which combines an ionization chamber and electrometer amplifier in the basic instrument with a plug-in (optional) Geiger–Mueller frisking probe (this combination of different detection and operational modes in one survey meter being referred to as hybrid instrument). The survey meter provides seven linear ranges for the measurement of gamma radiation dose-rates, from 1 mRad/h to 1000 RAD/h. The design is based on the dual utilization of a modular operational amplifier which, in connection with the ionization chamber (and high impedance input stage), acts as operational electrometer, or, with the Geiger–Mueller probe and range switching, is converted into a counting rate meter. The instrument is battery powered and features a presettable alarm. (auth)

637 WEIGHTED EFFICIENCY CALCULATIONS FOR NEUTRON DETECTORS. Reier, M. (EG and G, Inc., Goleta, Calif.). Nucl. Instrum. Methods, 65: 119-20(Oct. 15, 1968).

A simple technique has been developed, which accounts for the discriminator slope of the pulse-height distribution of a neutron detector at the bias and weighs the calculated efficiency over the bias region. (auth)

638 COINCIDENT SUMMING EFFECTS IN Ge(Li) DETECTORS. Luukko, A.; Holmberg, P. (Univ. of Helsinki). Nucl. Instrum. Methods, 65: 121-2(Oct. 15, 1968).

Coincident summing effects in Ge(Li) detectors in gamma spectroscopy are discussed. Consideration is given to nuclei which emit two gamma rays in cascade. (B.G.D.)

639 RADIOACTIVE PULSE LIGHT SOURCE FOR IN-FLIGHT CALIBRATION OF SCINTILLATOR PHOTOMULTIPLIER ASSEMBLY. Damle, S. V.; Joseph, G. (Tata Inst. of Fundamental Research, Bombay). Nucl. Instrum. Methods, 65: 123-4(Oct. 15, 1968).

A new in-flight calibration method for scintillator photomultiplier assembly is described. The pulse light source produced by a collimated ^{241}Am radioactive alpha source kept on a thin CsI(Tl) disc was used as the calibration source. This method is particularly suitable for thin scintillators. Its advantages and other possible applications are indicated. (auth)

640 FAST-SLOW COINCIDENCE SYSTEM. Iaci, G.; Lo Savio, M. (Univ., Catania, Italy). Nucl. Instrum. Methods, 65: 103-9(Oct. 15, 1968).

A fully transistorized fast-slow coincidence system is described. The triggering of the fast-signal shaping circuits happens at zero crossover of the slow input-signals. The device exhibits a 4 ns fwhm physical prompt resolution curve and allows a fast coincidence with 8 ns resolving time at 100% efficiency to be used. (auth)

641 THERMAL NEUTRON Gd-DETECTOR. Foglio-Para, A.; Gottardi, N. A.; Bettoni, M. Mandelli (Polytechnico, Milan). Nucl. Instrum. Methods, 65: 110-12(Oct. 15, 1968).

A thermal neutron detector, based on the measurement of the current of conversion electrons from a Gd target has been realized. Its principal features are the immediate response to flux variations and a good γ selectivity. (auth)

642 AN EFFECT OF SCATTERED NEUTRONS FROM PHOTOMULTIPLIERS ON THE NEUTRON SPECTRUM MEASURED BY ^{6}Li GLASS SCINTILLATORS. Ohkubo, M. (Japan Atomic Energy Research Inst., Ibaragi). Nucl. Instrum. Methods, 65: 113-14(Oct. 15, 1968).

The neutron spectrum measured by ^{6}Li glass scintillators has been found to have an enhancement peak at $E_n = 2.87$ keV, due to resonance scattering from ^{23}Na contained in the glass of photomultipliers. (auth)

643 DEVICE FOR MEASURING THE CONCENTRATION OF FISSION PRODUCTS IN SUSPENSION IN A FLUID. Douet, Paul; Roguin, Andre (to Commissariat a l'Energie Atomique). U. S. Patent 3,404,273. Oct. 1, 1968. Priority date Feb. 7, 1964, France.

A device for monitoring the concentration of fission products in fluids is described. This device is particularly useful for determining fuel element rupture in reactors by monitoring the coolant. (B.G.D.)

644 NEUTRON DETECTOR HAVING A RADIOACTIVE VANADIUM EMITTER. Andersson, Karl Osten Ingvar (to Aktiebolaget Atomenergi). U. S. Patent 3,400,289. Sept. 3, 1968. Priority date Feb. 8, 1965, Sweden.

A neutron detector which is based on the measurement of electron current of beta particles emitted from a material undergoing neutron activation is described. The materials considered are rhodium, silver, and vanadium. (B.G.D.)

645 REGISTRATION OF A GAMMA-RAY PULSE WITH A SEMICONDUCTING DETECTOR BASED ON CADMIUM TELLURIDE. Kireev, P. S.; Kalugina, L. I. (Moscow Steel and Alloys Inst.). JETP Lett. (USSR) (Engl. Transl.), 8: 44-5(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 73-5(July 20, 1968).

The sensitivity of cadmium telluride p-n junction detectors for studying the temporal characteristics of processes accompanied by gamma radiation was investigated. Two junctions were located in a gamma-ray beam produced by the 30-MeV electron linear accelerator at the Karchatov Atomic Energy Institute. The first junction was the detector being investigated and the second one was a p-i-n silicon detector for comparison. (B.G.D.)

646 DEAD-TIME CORRECTION IN NUCLEONIC COUNTER SYSTEMS. Taylor, D. Control, 12: 862-3(Oct. 1968).

The importance and method of correcting for the inoperative period or dead-time of radiation detectors are outlined. It is usual to follow the detector with an amplifier, a scaling circuit, and an electromechanical register. The effects of these pieces of equipment on the dead-time of the counter are discussed. (UK)

647 CONCENTRATION DEPENDENCY OF THE FLUORESCENCE FROM SOLUTIONS OF 2-PHENYL INDOLE AND DERIVATIVES OF 2-PHENYL INDOLE. I. FAST-ELECTRON EXCITATION. Horrocks, Donald L.; Wirth, Hermann O. (Argonne National Lab., Ill.). J. Chem. Phys., 49: 2907-12 (Oct. 1, 1968).

The relative scintillation yield for excitation with fast electrons was measured as a function of the concentration of the solute. The property of self-quenching of a series of 2-phenyl indole and 2-phenyl indole derivatives was correlated with the structure of the compound. It was shown that destroying the ability of the chromophore of the molecule to obtain a coplanar configuration would eliminate self-quenching in most cases. The exceptions were those derivatives which had an H atom on the N atom of the indole ring. It is believed that in these cases self-quenching may proceed through a hydrogen-bonding mechanism. The substitution on long-chain alkyl groups on the N atom of the indole did not eliminate self-quenching even for a 12-carbon-atom chain. There was a gradual decrease in self-quenching upon increasing the substituent from methyl to n-hexyl. (auth)

648 AIRCRAFT GUIDANCE SYSTEM FOR LOCATING A LANDING AREA. Campanella, Angelo J. (to Industrial Nucleonics Corp.). U. S. Patent 3,404,276. Oct. 1, 1968. Filed June 9, 1964.

An aircraft guidance system comprising of a collimated radiation source located in a landing area, the accessary detection equipment located on-board, and finally data analysis equipment for determining position and providing guidance information. (B.G.D.)

649 NEUTRON DETECTOR. Jonsson, Georg Salomon; Andersson, Karl Osten Ingvar (to Aktiebolaget Atomenergi). British Patent 1,131,729. Oct. 23, 1968. Filed July 6, 1967.

A radiation detector for measuring neutron flux in a reactor is described. The detector is based on electron current measurements from beta decay of a neutron-activated material. (B.G.D.)

650 EPITHERMAL NEUTRON WELL LOGGING. Hall, Hugh Edward (to Texaco Development Corp.). British Patent 1,131,406. Oct. 23, 1968. Filed Apr. 22, 1966.

The system consists of a scintillation or proportional counter which is sensitive to thermal neutrons, surrounded by an inner layer of neutron thermalizing material and an outer layer of thermal neutron absorbing material comprising an element having an absorption cross section for 0.025-eV neutrons at least 100 times greater than the absorption cross section for 1-eV neutrons and exhibiting no resonance capture in the neutron spectrum from 1 to 15 eV. (W.H.K.)

651 METHOD AND APPARATUS FOR RADIATION DIRECTION FINDING. Tolmie, Ronald W. (to Atomic Energy of Canada Ltd.). U. S. Patent 3,400,267. Sept. 3, 1968. Filed Apr. 18, 1966.

A method and apparatus for determining the direction of emission of radiation from a radioactive body independent of the intensity of the radiation are described. According to the method and the particular apparatus disclosed radiation is detected in at least two zones and signals are thereby generated that are representative of the radiation in each zone. The ratio of the signals is determined, and a resultant signal is produced. The resultant signal

is utilized to drive an indicator having a pointer which indicator uses the resultant signal to cause the pointer to point at the source of radiation. (auth)

652 SYSTEM FOR A.C. OPERATION OF AN IONIZATION CHAMBER. Amano, Noboru (to Japan Atomic Energy Research Inst.). U. S. Patent 3,400,268. Sept. 3, 1968. Priority date Dec. 23, 1963, Japan.

An ionization chamber operated by an ac source and a stable ac amplifier at the output of the chamber. A high pass or band pass filter in the output circuit passes only the odd harmonics of the frequency contained in the signal current but not the fundamental frequency of the leakage current. (auth)

653 PARTICLE IDENTIFIER WITH $\Delta E \times E$ SOLID STATE DETECTOR COUNTER TELESCOPE. Liu, Y. C. (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Peking) (Engl. Transl.), 6: 7-14(Apr. 1968).

A $\Delta E \times E$ counter telescope is constructed by 110 μ thick surface barrier S.S.D. as ΔE counter and 2mm thick lithium-drifted S.S.D. as E counter. The multiplying operation is performed by a logarithmic adding circuit using the logarithmic characteristics of p–n junction transistor 2SA206. The identifier system is used to separate the protons and deuterons in $^{7}Li + {}^{3}He$ reaction and the good separation is obtained for energy range from 4 MeV to 15 MeV. (auth)

654 DETECTION OF EXTENSIVE AIR SHOWERS OF COSMIC RADIATION WITH A NEON HODOSCOPE. Bonczak, Bazyli (Lodz Univ., Poland); Jatczak, Jerzy; Firkowski, Ryszard. Nukleonika, 13: 953-66(1968).

The construction of a neon flash-tube hodoscope consisting of thirty-six thousand Conversi detectors is described as well as the recording of extensive air showers of cosmic radiation with its help. The efficiency of the hodoscope and its dependence on certain parameters are determined. A telescope is described consisting of Conversi detectors in which the paths of the ionizing particles are shown. (auth)

655 PULSE SHAPE DISCRIMINATOR. Kozlowski, Tadeusz (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 13: 999-1000(1968).

In many scintillation detectors the signal pulse shape is dependent on the specific ionization of the incident particles. A considerable number of circuits have been developed for distinguish particles utili. ing the pulse shape differences. Many of these employ the zero-crossing method which is based on the time between inception and the zero-crossover is independent of the pulse height. However, in such circuits at least two sources of errors are possible: firstly, the overload conditions in the photomultiplier or in the circuit which reduce the permissible region of energies measured; secondly, the statistical fluctuations and noise effects which render good distinction of the different particles impossible due to their low energies. The circuit presented is based on this zero-crossing method and is constructed so as to minimize these effects. (auth)

656 SCINTILLATION GAMMA BACKGROUND MONITOR FOR FIELD MEASUREMENTS. Pensko, Jerzy; Glowacki, Stanislaw; Mamont, Kalina (Central Lab. for Radiological Protection, Warsaw). Nukleonika, 13: 1013-20(1968).

A portable monitor for field measurements of gamma background exposure rate is described. The instrument consist of NaI(Tl) crystal ($\phi 5'' \times 2''$), photomultiplier of 150 mm diameter, amplifier, and discriminator of variable level. The pulses from the discriminator are counted by a commercial scaler. The monitor makes it possible to evaluate the exposure rate from fallout gamma radiation in the presence of a natural gamma background. The energy spectrum of gamma background radiation can be obtained by applying the field pulse-height analyzer. (auth)

657 SIMPLE AND RAPID METHOD OF CHECKING THE OUTPUT OF SUPERFICIAL X-RAY AND GRENZ-RAY THERAPY MACHINES. Buchan, R. C. T. (Plymouth General Hospital, Eng.). Brit. J. Radiol., 41: 709-10(Sept. 1968).

A simple ionization chamber is described which can be used to check the output of x-ray and grenz-ray therapy machines. Construction details are included. (B.G.D.)

658 SEALED IONISATION CHAMBERS FOR X-RAY MONITORS. Nelson, K. A. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 41: 708-9 (Sept. 1968).

The construction of a variety of ionization chambers used as monitors in x-ray equipment is discussed. The design of these chambers depends essentially on the use of glass-to-metal vacuum seals as lead-throughs for the electrical connections to the plates of the ionization chamber, and O rings to seal the assembly from atmospheric changes. (B.G.D.)

659 RADIOISOTOPE SOURCE: TARGET ASSEMBLY FOR X-RAY SPECTROMETRY. Giauque, Robert D. (Univ. of California, Berkeley). Anal. Chem., 40: 2075-7(Nov. 1968).

A radioisotope source–target assembly for x-ray fluorescence analysis using lithium-drifted germanium and silicon as detectors is described. Some of the radioisotopes used as sources are ^{241}Am, ^{109}Cd, ^{125}I, and ^{57}Co. (B.G.D.)

660 PROCESS AND APPARATUS FOR THE DETERMINATION OF RADIOACTIVITY IN ATMOSPHERIC PRECIPITATIONS. Goupil, J. (to Commissariat a l'Energie Atomique). Canadian Patent 788,540. June 25, 1968. Priority date Sept. 1, 1964, France.

Electronic equipment is associated with a device for continuously collecting rainfall or other precipitation in a reservoir. The water is evacuated at a rate proportional to the reservoir level and the volume and radioactivity are continuously measured. The apparatus required is a buffer reservoir for collecting precipitation, an outlet pipe having a β-ray-detecting cup, an outflow regulating element, and a pressure pickup which responds to the reservoir level. A flow regulating element controls the flow at a value proportional to the water level and another element measures the volume. Measuring the whole volume continuously has an advantage over sampling at intervals. (Canada)

661 DEVICE FOR THE REPRESENTATION IN PLAN OF RADIATION EMITTED BY AN OBJECT. Leroy, M. (to Commissariat a l'Energie Atomique). Canadian Patent 788,037. June 18, 1968. Priority date Nov. 10, 1964, France.

Detection of local variations in the fixation of a radioactive tracer in medical diagnostics is an important use of this device. The distribution as revealed by a diagram called a cartogram is built up by a scanning process. A number of photoelectric cells combined with a rotating color filter sweep the area of interest with a light beam so that the scanning time is reduced to the order of milliseconds. A resulting colored image indicates the distribution of the radioactive tracer and thus aids the physician in making a diagnosis. (Canada)

662 DEVICE FOR MEASURING THE RADIOACTIVITY OF WATER. Courtois, A.; Laporte, A.; Grauby, A. (to Commissariat a l'Energie Atomique). Canadian Patent 784,314. Apr. 30, 1968. Priority date Aug. 12, 1964, France.

A self contained, immersible, automatic measuring and warning device is described. It consists of a detector adapted to supply electrical pulses, a pre-amplifier through which these pulses are to pass, a counting unit adapted to form amplified pulses, a programmer, a memory coupled to the counting unit and adapted to memorize the formed pulses, a magnetic recorder actuated by the programmer, a low and high voltage supply, a transmitter connected to the magnetic recorder and an alarm device connected to the counting unit. In use, the device is submerged and connected to a buoy by a cable to mark its location. Sensitivity to γ radiations at several dozen feet in depth is given as 8×10^{-7} Ci/m^3. (Canada)

663 SIMPLE METHOD OF DRIFT CONTROL FOR Ge(Li) DETECTORS. Rotolante, R. A.; Albridge, R. G.; Fleming, R. M. (Vanderbilt Univ., Nashville). Nucl. Instrum. Methods, 65: 235-6(Nov. 1, 1968).

A simple method is presented for controlling the drift of Ge(Li) diodes using a heat sink. The resulting characteristics of two 10 cm^3 detectors are discussed. (auth)

664 IMAGE FORMATION OF DETECTORS FROM THE INCIDENT GAMMA-RAY FLUX. Wilks, R. J. (Univ. of Aberdeen, Scotland). Phys. Med. Biol., 13: 585-95(Oct. 1968).

The primary γ-ray flux from area and volume sources incident on the detection surface of different types of scanning systems is calculated. The conversion of the γ-ray flux into displayed information by the particular image transfer system under consideration (e.g., Anger Gamma Camera) is investigated. A computer program is described which can evaluate the response of many different collimator channels at the same time. Comparison is made between theoretical and experimental results. (auth) (UK)

665 EXPLICIT ERROR CALCULATION FOR UNFOLDED SPECTRA OBTAINED BY FOIL ACTIVATION. Robkin, M. A. (Univ. of Washington, Seattle). Contract AT(04-3)-189. Nucl. Instrum. Methods, 65: 213-16(Nov. 1, 1968).

A distinction is made between convergence of an expansion and inherent statistical uncertainty in methods which obtain the energy spectrum of the flux from a set of foil activations. Testing a method against a hypothesized interesting flux only determines the convergence. The uncertainties in the parameters introduce a

separate error. The solution to the response matrix equation is obtained directly in terms of the eigenvectors of the response matrix. The amplification of statistical uncertainty due to ill conditioning is shown explicitly in terms of the eigenvalues of the response matrix. It is pointed out, then, that the only reliable test of the results of a method is either comparison with an independent measurement of the spectrum such as by a spectrometer or by comparison between calculated and measured activation of a set of test foils with very small uncertainty in their cross sections. (auth)

666 SOME READ-OUT SYSTEMS FOR PROPORTIONAL MULTIWIRE CHAMBERS. Charpak, G.; Bouclier, R.; Bressani, T.; Favier, J.; Zupancic, C. (CERN, Geneva). Nucl. Instrum. Methods, 65: 217-20(Nov. 1, 1968).

Several methods are discussed, which reduce substantially the number of amplifiers required for the readout of a proportional multiwire chamber. The plane of wires is built as a lumped delay line. The difference in the arrival time of the pulse at the two ends of the line determines the position of the active wire. Or, the wires are connected to a resistive attenuator network. The ratio of the pulse heights arriving at the two ends localizes the active wires. The wires can be connected in different subgroups by transformer coupling. (auth)

667 SIMPLE TECHNIQUE FOR MEASURING PULSE SHAPES FROM NUCLEAR DETECTORS. Larsen, R. N. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 65: 221-4 (Nov. 1, 1968).

A simple technique is described for measuring and recording pulse shapes and risetimes from nuclear detectors. The system uses a sampling scope as the basic component. Three dimensional data from the scope can be photographed and/or digitized and stored in a 2-parameter multichannel analyzer. The technique is applicable to scintillation detectors, solid state detectors, proportional counters, or any device with an output risetime from a few nsec to several μsec. The system can be assembled from general purpose instruments commonly found in most laboratories. Pulse shape distributions from several types of detectors are presented. (auth)

668 SENSITIVE TELESCOPE FOR GAMMA RAY ASTRONOMY AT BALLOON ALTITUDES. Board, S. J.; Dean, A. J.; Ramsden, D. (Univ. of Southampton, Eng.). Nucl. Instrum. Methods, 65: 141-51(Nov. 1, 1968).

A telescope suitable for gamma ray astronomy at balloon altitudes is described. This comprises a 42 gap spark chamber and associated event selection counters. The chamber has a sensitive area of 3000 cm^2 and a conversion efficiency of 35% for 100 MeV gamma rays. The data are recorded photographically on 1.2 km of film. Two independent attitude sensing systems provide information on the orientation of the telescope to within $\pm\frac{1}{2}°$. Provisions are included to permit the attitude to be controlled by ground command. A sensitivity for discrete sources of 5×10^{-7} photons/cm^2 · sec may be achieved with a flight of 8 h duration at an altitude corresponding to 3 g/cm^2. (auth)

669 TIME MEASURING CIRCUITS FOR FAST NUCLEAR LIFETIME SPECTROSCOPY. Tamminen, A.; Jauho, P. (Technical Univ. of Helsinki). Nucl. Instrum. Methods, 65: 132-6 (Nov. 1, 1968).

A photomultiplier anode pulse limiter and two versions of the same simple Weisberg type time-to-amplitude converter are described. The tunnel diode converter circuit operates with short constant-charge input pulses which are formed by using a step recovery diode in the output of the limiter circuit. The integral and differential linearities of the useful part of the time scale are better than ±0.2% and ±5% respectively. The electronic resolution is about 5 ps, and a time resolution (fwhm) of 210 ps has been obtained with a ^{60}Co source and XP1021 photomultipliers. (auth)

670 INTERACTION BETWEEN CLOSELY-SPACED INDIUM FOILS IN LIGHT WATER. Khan, N. A.; Golam Mostafa, A. B. M.; Irshad, M.; Haroon, M. R.; Faruqi, A. R. (Atomic Energy Centre, Lahore). Nucl. Instrum. Methods, 65: 137-40(Nov. 1, 1968).

Interactions between closely-spaced indium disc foils of 1 cm dia. and 0.0127 cm thick exposed to an isotropic thermal flux in light water, were experimentally studied with a view to establish the closest distance between them at which no significant perturbation was experienced. This investigation, therefore, was undertaken to determine the flux perturbation factors (defined as the ratio of thermal neutron flux present in the foil to the unperturbed thermal neutron flux) for various interfoil distances. It was observed that these factors changed from a value of 0.833 ± 0.019 (large perturbation) for 1.5 cm interfoil distance (center to center) to 0.986 ± 0.015 (small perturbation) for 1.8 cm interfoil distance, where the unperturbed flux was taken as the measurement with indium foils being 6 cm apart. It was, therefore, concluded that interaction between neighboring foils of 1 cm dia. and 0.0127 cm thick became small for interfoil separations greater than 1.8 cm. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 47, 629, 726, 1580, 1821, 1830, 1878, 1879, 1908, 1943, and 1956.

671 (CEA-R-3415) STUDY OF SEMI-CONDUCTOR SPECTROMETERS FOR HIGH COUNTING RATES. APPLICATION TO THE STUDY OF THE REACTION $^{31}P(p,\alpha_0)$: $E_p < 2$ MeV. Ligeon, Emile (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1968. 98p. (In French). Dep. Thesis. Submitted to Univ., Grenoble, France.

The study of nuclear reactions involving particles of low charge (E < 2 MeV) calls for spectrometers of high-resolving power. In many experiments however, the counting rate is high because of Coulomb scattering at the target: this results in a distortion of the experimental spectra and a loss of resolving power in the detection equipment. The first part is devoted to an evaluation of the resolving power obtained with silicon-detector spectrometers. A study of the elastic scattering of protons by ^{31}P shows which are the factors limiting the resolving power. In the second part the various types of spectrometers which can be used in the case of a high count rate are examined. An apparatus which can be used for carrying out spectrometry on particles produced by nuclear reactions, for a total count-rate of 10^6 counts/sec, is described. Our apparatus, used for the study of the reaction $^{31}P(p,\alpha)$ from 1 to 2 MeV, has made it possible to reduce the duration of an experiment by a factor of about 7. The ^{32}S levels have been studied and determined in the excitation range 9.851 to 10.838 MeV. (auth)

672 (UCRL-18317) RAPID SPECTROMETER ANALYSIS. Wicklund, Arthur B. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1968. Contract W-7405-eng-48. 38p. Dep. CFSTI.

A general solution of Maxwell's equations which describes the field of a spectrometer magnet with precision and accuracy is presented. For example, starting with 70,000 field measurements made on an 18 × 36 × 8-in. bending magnet (AEC 67 522) 200 parameters emerge which describe all components of the field everywhere at all currents with errors less than 4×10^{-4} of the central field values (typically 1 or 2 gauss out of 15,000); measured line integrals are reproduced within one part in 10^4. To summarize the solution: the field is described by cuts and poles near the real axis defined by the longitudinal path through the field. Particle orbits have a corresponding singularity structure. Inhomogeneities in the field are introduced as perturbations on the residue functions which depend on the orbit characteristics; by means of the residue theorem, one can take these inhomogeneities into account by simply adding up the perturbed residue functions. The essential mathematical simplification which has been achieved is this; instead of expanding field inhomogeneities as polynomials in the coordinates and integrating these along a path, they are expanded in a series of increasingly higher-order poles and then, because of the residue theorem, only the first term in this series is retained. Finally it is noted that nature is happy with this solution; the accuracy of any momentum analysis done with the spectrometer is limited only by uncertainties in the original field measurements. With modifications the ideas presented here can be extended to larger, more complicated fields. Analysis capabilities are buttressed by the fact that with a typical spark chamber setup, one can fit orbits, compute χ^2's and measure momenta at the rate of 16,000 tracks per minute on the CDC 6600, using the techniques outlined. (auth)

673 DETERMINATION OF THE AMOUNT OF NATURAL RADIOACTIVE NUCLIDES IN SOIL AND CONSTRUCTION MATERIALS BY MEANS OF γ-RAY SPECTROMETRY. Keil, R. A.; Rajewsky, B. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Atompraxis, 14: 421-6(Sept.-Oct. 1968). (In German).

An energy-range method is described for determining the nuclide concentrations of ^{232}Th, ^{226}Ra, and K_{nat} in soil and construction materials with the aid of a gamma-ray scintillation spectrometer. The setup was calibrated and gauged with solutions of ^{226}Ra chloride, ^{232}Th nitrate, and K_{nat} chloride. With this method it is possible to determine concentrations of these nuclides with an accuracy of more than ±1%. The values measured with this setup for ^{238}Th, ^{228}Ra, ^{232}Th, ^{226}Ra, and K_{nat} in characteristic soil and construction-material types are listed. (auth)

674 CALIBRATION OF A GAMMA-RAY SPECTROMETER FOR SOILS COUNTING. Lloyd, R. D.; Aamodt, R. L.; Wagner, W. W.; Pendleton, R. C. (Univ. of Utah, Salt Lake City). Int. J. Appl. Radiat. Isotop., 19: 773-5(Oct. 1968).

The concept of determining the empirical correction factors and their use in calculating activity concentrations in soil samples is discussed. Three sets of four solutions of soil and zinc chloride, having measured densities of 1.0, 1.3, 1.5 and 1.8 g/cm^3, were prepared in 4 litre polyethylene jugs. Replicate activities of ^{137}Cs were added to one set, ^{40}K to another set and no activity was added to the third. The sets containing ^{137}Cs and ^{40}K were counted between NaI(Tl) crystals to determine the effect of sample density in counting rate both in the primary photopeak and in the Compton continuum. The effect of sample volume on counting rate was also determined. Counting rates in the photopeak for both ^{137}Cs(0.66 MeV) and ^{40}K(1.46 MeV) can be described by the expressions: Std_D (for ^{137}Cs) = Std, $(e^{-0.243}[D-2])$ (1) Std_D (for ^{40}K) = Std, $(e^{-0.190}[D-2])$ (2), where Std is the counting rate of standard of density 1 g/cm^3, and Std_D is the counting rate of standard of density Dg/cm^3. Pairs of standards in which identical activities had been put into (a) 4 litre of water in a jug (b) a 10 ml glass ampoule, were counted placing the ampoule member of the pair in the centre of 4 litre jug of water. Nuclides utilized were ^{125}Sb, ^{106}Ru, ^{137}Cs, ^{95}Zr, ^{54}Mn, ^{228}Ra + ^{228}Ac, ^{40}K, and ^{228}Th + ^{208}Tl. Each ampoule standard was counted in the centre of the series of Zn Cl_2 absorbers that contained no added radioactivity. A sealed ^{226}Ra ampoule was similarly counted. The data obtained from the experiments were used to calculate expressions similar to (1) and (2) for each nuclide. For the ^{137}Cs and ^{40}K distributed sources, counting rates in the Compton continuum were virtually independent of density. The effect of sample volume on counting rate could be described by the expression: $R_v = R_4 [1 + 0.08 (4 - V)]$ (3) where R_4 is the counting rate of the 4 litre sample and R_v is the counting rate of an identical activity in V litres. The expressions derived from this calibration study were incorporated into a computer program which was designed to yield activity concentration in soil samples from an input consisting of counting data from the samples and appropriate standards of density 1.0 g/cm^3. (UK)

675 FAST RECORDING ELECTROSTATIC ENERGY-ANALYZER FOR ELECTRONS. Aumueller, W. (Univ., Tuebingen, Ger.). Optik, 27: 577-81(Sept. 1968). (In German).

A fast recording electrostatic energy-analyzer for 10- to 40-keV electrons is described. A battery operated, transistorized sawtooth-generator deflects the energy spectrum from the analyzer-lens over a recording slit. The transmitted current is multiplied and displayed on a CRT. The height of the sawtooth voltage can be varied from 8 to 18 volts. The energy scale can be estimated with an error smaller than 0.1 eV. An energy distribution can be recorded in about one second. (auth)

676 GAMMA-ACTIVATION METHOD OF SPECTROSCOPY FOR γ-IRRADIATION. Abrams, I. A.; Pelekis, L. L. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 3-6(1968). (In Russian).

A method is suggested for determining the energy distribution of dispersed γ-quanta of powerful γ-irradiation sources which is based on γ-activation of ^{77m}Se, ^{87m}Sr, ^{107m}Ag, ^{109m}Ag, ^{111m}Cd, ^{113m}In, ^{115m}In, and ^{199m}Hg isomers. The measurements of the dispersed γ-quanta spectrum of the irradiator in the region 0.9 to 2.0 MeV are found to be in a good agreement with the results obtained by means of scintillation γ-spectrometer on the model of the irradiator. (auth)

677 SYSTEM FOR RAPID CHEMICAL SEPARATION AND SPECTROSCOPIC EXAMINATION OF FISSION GASES. Alexander, P.; Lau, J. P.; Sahagian, A. V. (ISOTOPES, A Teledyne Co., Westwood, N. J.). Nucl. Instrum. Methods, 64: 323-7(Oct. 1968).

A system which allows examination of the direct fission population of the isomeric and ground states of the noble gases is described. The decay properties of such states of intermediate lifetime may also be studied by use of this system. Rapid chemical separation of the selected fission gas from the bulk fission product is necessary so that the fission chain population of the states of interest are kept small compared to the direct population. To achieve this condition the irradiated fission source, which is contained in a gas-tight, dissolvable capsule, is delivered by a rabbit to the system and dissolved in a pre-equilibrated aqua regia solution. The released gas is chromatographed and recovered quantitatively with no detectable impurities and with efficiencies approaching 100%. The chemical separation time involved in this procedure is roughly two minutes from the end of irradiation. The separated gas is immediately delivered to a thin aluminum disc held at −196°C in an evacuated system. The gamma rays and electrons from the source gas frozen on this disc may be examined with Ge(Li) and Si(Li) detectors located on opposite sides of the disc. Using this system the direct fission yield of ^{133}Xe and ^{133m}Xe have been determined and nuclear structure properties of these nuclei have been measured. (auth)

678 AN ULTRA-HIGH RESOLUTION Ge(Li) SPECTROMETER FOR SINGLES AND COINCIDENCE X-RAY AND GAMMA-RAY STUDIES. Palms, J. M.; Rao, P. Venugopala; Wood, R. E. (Emory Univ., Atlanta). Nucl. Instrum. Methods, 64: 310-16 (Oct. 1968).

The characteristics of a small (8 mm dia, depletion depth 4 mm) ultra high resolution (fwhm-450 eV at 14 keV and 1.7 keV at 1332 keV) Ge(Li) spectrometer are described. In particular the following were studied: resolution versus energy, the Fano factor for Ge, the full energy and K x-ray escape efficiency, and the detector linearity. Besides being used to measure singles spectra over the energy region from 6 keV to 2 MeV, the detector was used simultaneously with a high resolution Si(Li) detector to measure coincidences between $K_{\alpha 1}$, $K_{\alpha 2}$, and L x-rays. (auth)

679 Ge(Li)-GAMMA SPECTROMETER FOR LOW GAMMA ACTIVITIES. Kemmer, J. (Technische Hochschule, Munich). Nucl. Instrum. Methods, 64: 268(Oct. 1968). (In German).

By using a well type Ge(Li)-diode with a drifted volume of 9 cm^3 mounted in a special cryostat, it becomes possible to measure γ-activities with 2% absolute efficiency at 500 keV. (auth)

680 ELECTROSTATIC ENERGY ANALYZER FOR STUDYING GAS-FOCUSED ELECTRON BEAMS AND THEIR BACKGROUND MEDIA. Stephanakis, Stavros; Bennett, Willard H. (North Carolina State Univ., Raleigh). Rev. Sci. Instrum., 39: 1714-20(Nov. 1968).

An analyzer is described which is especially suitable for the study of electrostatically self-focusing electron beams and their associated background media, and, in general, for media which by their nature are very sensitive to direct insertion of probes or other diagnostic devices. The basic difficulties with devices of this nature, namely, the continually changing work functions of metal surfaces due to sorbed films and the lens effect defocusing due to nonuniformities of the potential in the neighborhood of grid wires, have been identified and effectively overcome. The analyzer is employed flush with the boundary of the medium under study and it incorporates a shielding electrode so that the disturbance of the medium is insignificant. When the dimensions of the instrument are scaled so that the space charge effects are absent, it can be utilized successfully to detect energy spreads as small as a few tenths of an electron volt. (auth)

681 USE OF THE INTEGRAL-BIAS SUMMING COINCIDENCE SPECTROMETER IN DIRECTIONAL CORRELATION MEASUREMENTS. Hattula, J.; Kantele, J.; Sarmanto, A. (Univ. of Jyvaeskylae, Finland. Univ. of Helsinki). Nucl. Instrum. Methods, 65: 77-84(Oct. 15, 1968).

The performance of the integral-bias summing coincidence spectrometer (the sum-peak spectrometer) in measurements of directional correlations of gamma rays has been tested. As compared with the conventional method, the sum-peak spectrometer is easier to use and seems to yield results which agree with those obtained with the ordinary method. Because of the complex shapes of response functions of gamma rays above about 3 MeV, the new method is best suited to the study of cascading transitions below this energy, where the two methods appear to complement each other. The analysis of the sum-peak spectra in the present work is based on a simple graphical method which seems to yield satisfactory results; the use of a computer method is suggested. Some previously unknown directional correlation functions of gamma-ray cascades in ^{106}Pd and ^{118}Sn are also reported. (auth)

682 CALIBRATION OF AN ORGANIC SCINTILLATOR FOR NEUTRON SPECTROMETRY. Verbinski, V. V. (Oak Ridge National Lab., Tenn.); Burrus, W. R.; Love, T. A.; Zobel, W.; Hill, N. W.; Textor, R. Nucl. Instrum. Methods, 65: 8-25 (Oct. 15, 1968).

The absolute differential efficiency of a 4.60- × 4.65-cm-dia liquid organic scintillator, NE-213, was determined for nearly mono-energetic neutrons at 20 energies between 0.2 and 22 MeV incident on the curved side of the detector. These calibrations are shown to apply to an NE-211 scintillator as well. A 5-MeV Van de Graaff generator provided 2-nsec pulses of neutrons by means of T(p,n)^{3}He, D(d,n)^{3}He (gas target), and T(d,n)^{4}He reactions. With the aid of time-of-flight techniques and pulse-shape discrimination to eliminate spurious neutron and gamma-ray events, reliable pulse-height spectra were obtained for monoenergetic neutrons. The spectra were normalized to Monte Carlo calculations of absolute differential efficiency by utilizing the proton-recoil plateau. The accuracy of the Monte Carlo calculation was verified in the region of the proton-recoil plateau by absolute experimental calibrations carried out at neutron energies of 2.66 and 14.43 MeV and by using a scintillator geometry more suitable for such tests. (auth)

683 PRECISE DETERMINATIONS OF HIGH-ENERGY GAMMA RAYS AND ERRORS IN THE PAIR-PEAK METHOD. Gunnink, R.; Meyer, R. A.; Niday, J. B.; Anderson, R. P. (Univ. of California, Livermore). Nucl. Instrum. Methods, 65: 26-30 (Oct. 15, 1968).

Ge(Li) detector systems have been used in the measurement of more than 70 gamma rays at high precision. A previously unreported source of error in the pair-peak technique of extending measurements to higher energies is discussed in detail. A useful set of self-consistent and precise standard energies for use in nuclear spectroscopy has been developed. In addition, new energy values are reported for the principal gamma rays of ^{24}Na, ^{56}Co, ^{88}Y, ^{124}Sb, ^{140}La, and ^{208}Tl. (auth)

684 DUAL SPACE-TIME FAST-NEUTRON SPECTROMETER. DeJuren, J. A. (Northrop Corp. Labs., Hawthorne, Calif.). Nucl. Instrum. Methods, 65: 58-60(Oct. 15, 1968).

Some ideas to improve the resolution of fast neutron spectrometers are given. If part of the initial neutron energy is deposited in a recoil proton counter and the remaining energy of the scattered neutron is measured by time-of-flight, the resolution will be vastly improved by recording the energies simultaneously. Background effects caused by non n-p scattering events will be easily eliminated by the kinematic relations. (auth)

685 LARGE AREA SILICON SURFACE-BARRIER DETECTOR FOR BETA-RAY SPECTROSCOPY. Tomlinson, F. K.; Coffey, D. L.; Wylie, K. F. (Monsanto Research Corp., Miamisburg, Ohio). AT-33-1-GEN-53. Nucl. Instrum. Methods, 65: 101-2(Oct. 15, 1968).

The construction and operation of silicon surface-barrier detectors with active areas of 200 mm^2 is described. At 77°K, the resolution of the detectors yielded a fwhm of approximately 14 keV for the 625 keV conversion electrons of ^{137}Cs. The pulse height and resolution were found to be constant for reverse biases in the range of 200 to 400 V. At these voltages, the leakage current is less than 0.01 μA. (auth)

686 CONSTANT VELOCITY DRIVE FOR MOESSBAUER EFFECT ANALYZER. Jerko, David A. (to International Chemical and Nuclear Corp.). U. S. Patent 3,404,277. Oct. 1, 1968. Filed Sept. 4, 1964.

A Moessbauer spectrometer which has a mechanical drive system for maintaining the velocity of a gamma source relative to an absorber constant. (B.G.D.)

687 A $4\pi\beta$-SPECTROMETER WITH Li-Si COUNTERS. Andersen, V. (Danish Atomic Energy Commission, Roskilde, Denmark). Nucl. Instrum. Methods, 65: 225-7(Nov. 1, 1968).

A $4\pi\beta$-spectrometer provided with solid-state detectors has been developed. With the first stage of the preamplifiers cooled, a resolution of better than 0.8% at 1 MeV has been obtained. (auth)

688 DIGITAL CONTROL SYSTEM FOR NEUTRON SPECTROMETERS. Hansen, K. B.; Skaarup, P. (Danish Atomic Energy Commission, Roskilde, Denmark). Nucl. Instrum. Methods, 65: 152-6(Nov. 1, 1968).

A description is given of the principles of a digital system used to control neutron spectrometers. The system is composed of independent functional units with the control program stored on punched paper tape or in a computer. (auth)

689 PAIR AND ESCAPE-SUPPRESSED SPECTROMETER USING Ge(Li) AND NaI(Tl) DETECTORS DESIGNED FOR ACCELERATOR EXPERIMENTS. Alexander, T. K.; Broude, C.; Haeusser, O.; Sharpey-Schafer, J. F. (Chalk River Nuclear Labs., Ont.). Nucl. Instrum. Methods, 65: 169-72(Nov. 1, 1968).

A high resolution gamma-ray spectrometer consisting of a 40 cm^3 Ge(Li) detector located at the common center of two semi-annular NaI(Tl) detectors has been assembled for use in particle accelerator experiments. The three detectors are operated in a triple coincidence and an anti-coincidence mode, simultaneously yielding pair and escape-suppressed spectra in which background and the multiplicity of gamma-ray peaks are reduced. In the pair spectrometer mode the background is reduced considerably relative to the double escape peak, e.g., a factor of 20 for a 3.85-MeV gamma ray, and in the escape-suppressed mode by a factor of three to four. The performance of the spectrometer is demonstrated using a Pu-^{10}B gamma-ray source. (auth)

690 CONTRIBUTION TO THE PROBLEM OF THE UNFOLDING OF MEASURED SPECTRA. Weise, K. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 65: 189-94(Nov. 1, 1968).

A formal unification is given of some methods for unfolding a multichannel measurement in nuclear spectroscopy using modified least-squares technique to damp unrealistic oscillations of the solution caused by statistical fluctuations of the measured spectrum. To determine the strength parameter of damping, it is proposed to minimize the total quadratic error, which is the sum of the squares of the methodical error and the propagated statiscal errors of the measurement. (auth)

High Energy Physics Instrumentation

Refer also to abstract 1628.

691 (JINR-P13-4059) OPTICAL ANISOTROPY OF THE SAFETY GLASS IN THE 5-METER HYDROGEN CHAMBER. Zapletal, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 36p. (In Russian). Dep.

The data are presented for determination of the optical anisotropy of the 5-meter bubble chamber safety glass. (auth)

692 AN 80 cm LIQUID HELIUM BUBBLE CHAMBER. Roaf, D.; Bailey, C. A.; Davey, G.; (and others) (Nuclear Physics Lab., Oxford. Imperial Coll. of Science and Tech., London). Nucl. Instrum. Methods, 64: 301-9(Oct. 1968).

An 80 cm long liquid helium bubble chamber has been designed and commissioned as a joint project by Oxford University Nuclear Physics Laboratory and the Rutherford High Energy Laboratory for use with Nimrod, the Rutherford Laboratory 7-GeV proton synchroton. The work was carried out under a contract from the Science Research Council. The chamber is rectangular in shape and has a useful volume of 120 liter. Liquid expansion is achieved by means of a metal bellows, and the chamber operates in a vertical magnetic field. A direct illumination system is used with four light sources below the chamber and four cameras above. (auth)

693 SEARCH STATISTICS OF RARE EVENTS. Shen, M.-L. (Bartol Research Foundation, Swarthmore, Pa.). Nucl. Instrum. Methods, 65: 157-62(Nov. 1, 1968).

The statistics associated with the search of rare events is discussed for the simplest case in which only two scanners are employed. It is found that the maximum likelihood estimator for the number of events in m repeated scanning processes is the solution of a $(2m-1)$ order algebraic equation. Two practical approaches are suggested and are briefly compared. The cases for three scanners, and more generally t scanners are briefly discussed. (auth)

Radiation Dosimeters

694 (BNWL-SA-1830) RESPONSE OF SELECTED THERMOLUMINESCENT MATERIALS TO FAST-NEUTRON EXPOSURES. Endres, G. W. R.; Kocher, L. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1968. Contract AT(45-1)-1830. 13p. (CONF-680920-6). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

Studies to determine the optimum thermoluminescent material for personnel fast-neutron dosimetry are described. Response curves for various thermoluminescent materials for monoenergetic neutrons from 0.02 to 5 MeV are presented. Thermoluminescent materials studied were lithium fluoride (TLD-100, -600, and -700), lithium tetraborate, calcium fluoride, and beryllium oxide. (W.H.K)

695 (BNWL-SA-1831(Rev.)) NEUTRON DOSIMETRY WITH ACTIVATION FILTERS AND TLD. Kocher, L. F.; Endres, G. W. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 5, 1968. Contract AT(45-1)-1830. 15p. (CONF-680920-3). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

A TLD dosimeter technique has been developed to quantitatively determine fast and thermal neutron dosages from mixed radiation exposures. For fast neutron dosimetry, this method takes advantage of the scattering of thermalized neutrons from a hydrogenous moderator. The dosimeter housing consists of a standard Hanford beta-gamma film badge dosimeter. Three filters, consisting of combinations of lead, stainless steel, tin, cadmium, and rhodium are matched so as to produce equal TLD response from photon radiations. The fast and thermal neutron exposure is determined from the TLD response produced by the capture of moderated neutrons in the filter material. Where heterogenous radiation fields are encountered, a portion of the thermal neutrons is absorbed in one of the rhodium filter sandwiches. This differential forms the basis of a system to distinguish between fast and thermal neutrons. During design and exposure, a large piece of polyethylene was used as a phantom. Dosimeters were attached to the polyethylene and exposed to radiation from various isotopic neu-

tron sources (PuF_4 and PuBe) and monoenergetic neutrons generated by a positive ion accelerator. Thermal neutron exposures were conducted in a calibrated paraffin tank using the PuF_4 source to supply the neutrons. The dosimeter can also serve for photon dosimetry. (auth)

696 (HASL-201) LOW DOSE MEASUREMENTS WITH THERMOLUMINESCENT DOSIMETERS. Shambon, Arthur; McLaughlin, James E. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct. 1968. 11p. Dep. CFSTI.

CaF_2:Mn and LiF systems were investigated for suitability in measuring small amounts of gamma radiation. It was found that doses as low as 2 mR for the CaF_2:Mn system and 11 mR for LiF can be determined by careful measurement. The CaF_2:Mn shielded dosimeters require a correction of slightly less than 0.5 mR per day due to the ^{40}K radioactivity in the glass surrounding the phosphor. Comparison of CaF_2:Mn dosimeters with film badges exposed to 1.0 R and less showed better results for the CaF_2:Mn dosimeters in the region below 100 mR. The film badge readouts showed sizeable departure from linearity with exposure in this region. When the mean value of a number of dosimeter readouts for each exposure was used, good linear response was found with LiF extruded and pellet dosimeters from 150 R down to 11 mR. Improved heating methods should result in readouts from any dosimeter within 10% of the mean value at each exposure. (auth)

697 (NVO-162-27) COMBINATION PERSONNEL DOSIMETER AND SECURITY CREDENTIAL HOLDER. Brady, William J.; Iverson, Garn K. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev. Radiological Sciences Dept.). Oct. 1967; Revised Sept. 1968. Contract AT(29-2)-162). 36p. Dep. CFSTI.

A combination dosimeter and security credential holder was developed to provide the increased personnel dosimetry capability necessary to meet radiation exposure problems associated with nuclear rocket testing and underground detonations. The holder has capabilities for determining beta, x-ray, gamma, thermal neutron, fast neutron, high-range gamma, and high-range neutron doses. The holder is designed to accommodate a duPont Type 556 film packet, a fast neutron packet, an identification plate, criticality components, the security credential, and a snap-tie clip. The body of the holder is Cycolac plastic (styrene-butadiene-acrylonitrile). The fully equipped combination security credential and holder weigh 40 grams. The credential may be worn separately or with the holder. (B.G.D.)

698 (UCRL-71089) HOT NITROGEN GAS FOR HEATING THERMOLUMINESCENT DOSIMETERS. Petrock, K. F.; Jones, D. E. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 13, 1968. Contract W-7405-eng-48. 22p. (CONF-680920-5). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

Improvements in TLD reader design, especially the use of hot nitrogen gas for the heating of TLD phosphors, are described. This heating mechanism has been in use for several months in an automatic TLD reader designed at LRL. The reader reads 80 extruded LiF rods over a dynamic range of 3 mR to 1000 R in 40 min or less. The improved electronics gives a digital light sum and can simultaneously give digital glow curves for all except the minimum doses. This reader has proven to be extremely reliable as well as relatively simple in construction. The hot-gas heating technique was found to have some excellent characteristics: it is very efficient, it gives a low thermal glow and there is no heater pan to change in emissivity or reflectivity, and the background thermal glow is nearly constant throughout the reading cycle. With this system, one can bias out the photomultiplier tube dark current and part of the thermal glow so that a minimum signal is seen from an undosed detector. Thus, the system can automatically sense whether a dosimeter enters the readout chamber and is heated properly; no added electronic complication is necessary and there is no appreciable effect upon dynamic range. This may be useful to establish evidence of proper operation of a TLD system for personnel monitoring records. The success of the automatic reader has prompted consideration of heating other phosphor configurations. A manual hot-gas reader for reading all present solid types of TLD's is described. Data are shown for some representative TLD's. Results are also given showing the feasibility of hot gas heating for TLD powdered phosphors. (auth)

699 TWO-LEVEL ISOTHERMAL READ-OUT FOR HIGH PRECISION THERMOLUMINESCENCE DOSIMETRY WITH LiF. Burch, William M. (Cancer Inst., Melbourne). Phys. Med. Biol., 13: 627-34(Oct. 1968).

Manipulation of a simple first-order kinetics model to describe the emission of thermoluminescence from LiF leads to a useful expression relating phosphorescence life-time and glow-peak temperature. The interpretation of the expression is directly applied to the design of a TLD reader. A simple prototype instrument gave measurement precision of 1% for doses above 100 rads, and can read-out a phosphor without requiring knowledge of post-irradiation time. Details of the instrument and its performance are discussed. (auth) (UK)

700 INTEGRATING DOSIMETRY BY THERMALLY STIMULATED EXOELECTRON (AFTER-) EMISSION. Becker, K.; Robinson, E. M. (Oak Ridge National Lab., Tenn.). Health Phys., 15: 463-6(Nov. 1968).

The quantitative measurement of optically or thermally stimulated emission of low energy electrons from the surface of irradiated ionic crystals can be employed as a method of integrating radiation dosimetry, and a reader is described for investigations on this technique, using only standard laboratory equipment, and based on a gas-flow GM counter whose counting volume contains a circular heating element on to which a sample on a disc-shaped carrier can be placed. If the electron emission rate is plotted as a function of temperature, TSEE curves similar to TLD glow curves are obtained. Some experimental results for TSEE rates in gamma irradiated mixtures of BeO and LiF are shown. In other experiments BeO/C discs were exposed to gamma irradiation and read at different times after exposure. The number of released (exo)electrons is a linear function of dose. Net pulses per heating cycle as a function of 1250 keV radiation dose are shown graphically for these detector discs together with calculated energy response curves. TSEE offers several advantages over TLD, such as a very high sensitivity for some detectors, adjustable energy and LET response, a very thin sensitive layer for microdosimetry, and a wide choice of detector materials. (UK)

701 PRE-IRRADIATION ANNEALING OF TLD LITHIUM FLUORIDE. Harris, A. M.; Jackson, J. H. (Central Electricity Generating Board, Berkeley, Eng.). Health Phys., 15: 457-61(Nov. 1968).

The optimum annealing procedure required to produce high sensitivity and low background TLD LiF phosphor was found to be: (1) Anneal for between 10 and 100 minutes at 500 ± 25°C followed by a rapid cool; (2) anneal at 75 ± 10°C for between 10 and 50 hr. In practice, it was found that a suitable phosphor was obtained by annealing a thin layer of powder in a glass petri dish at 500°C for 1 hr, cooling this on a cold brass block to room temperature, and then annealing for 24 hr at 80°C. Experiments have shown, however, that the optimum annealing conditions may vary slightly from batch to batch. (auth) (UK)

702 OPTICAL PROPERTIES OF LiF DOSIMETRIC CRYSTALS. Grube, M. M.; Shvarts, K. K.; Grant, Z. A. Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 4, 7-12(1968). (In Russian).

Color centers and luminescence of LiF-Mg, Ca crystals applied to thermoluminescence dosimetry were studied. The thermoluminescence curve contains eight peaks: at 140°C, 175°C, 200°C, 240°C, 290°C, 330°C, 400°C, and 480°C. The peaks at 140°C, 175°C, and 200°C are connected with supplementary absorption bands in the region 240 to 400 nm. The maximum intensity peak at 240°C and the high-temperature peaks are connected with the F-band and neighbouring short-wave bands. Four bands (120 nm, 138 to 144 nm, 170 to 190 nm and 190 to 200 nm) are detected in the excitation spectrum. The maximum of the emission spectrum is located in the 410 nm region. (auth)

703 USE OF GLASS DOSIMETER IN FOOD IRRADIATION. Ojima, Tsutomu; Toratani, Hirokazu; Fujimoto, Hiroshi. Annu. Rep. Radiat. Center Osaka Prefect., 8: 106-11(1967).

Three kinds of cobalt- and a silver-activated glass colorimetric dosimeters were examined for their precision and range of measurable dose. The dose dependence of absorbance of glass colored by irradiation was linear up to a certain dose, where saturation effect appeared. No significant effect of temperature on coloration of irradiated glass was found among the conditions of 29°C, 0°C, -72°C, and -196°C. The glass dosimetry for irradiated blocks of beef and tuna was carried out. (auth)

704 LiF PELLET DOSEMETER. Shambon, A.; Condon, W. (Atomic Energy Commission, New York). Phys. Med. Biol., 13: 653-5(Oct. 1968).

A method is described for combining LiF powder with commercial stock sodium silicate solution (40-42°, Baumé) into a pellet which gives reproducible measurements of x-ray exposures down to 11 mR. (UK)

705 ABSOLUTE MEASUREMENT OF GAMMA RAY DOSE OF ^{60}Co. Kawashima, Katsuhiro; Tobe, Tatsuo (Gunma Univ., Japan). Kitakanto Igaku, 18: 60-5(Jan. 1968). (In Japanese).

Problems in making a reference chamber are investigated in-

cluding wall materials, energy response, dose rate dependence of beam direction, polarity effects, and noise from the connecting cable. Exposure rate in a 10 × 10 cm field at 75 cm S.S.D. from a cobalt teletherapy device is measured using a homemade parallel-plate ionization chamber made of lucite with a vibrating reed electrometer which indicates the voltage across the high resistance of 10^9 ohms. Corrections are made for backscatter, front wall absorption and general recombination. Precision or reproducibility of the present experiments is less than 1%, but their accuracy is about 6%. (NSA of Japan)

706 RADIATION SENSITIVE DEVICES. Bryer, Robert G. (to R. A. Stephen and Co., Ltd.). U. S. Patent 3,404,272. Oct. 1, 1968. Priority date May 22, 1963, Great Britain.

A silver-activated metaphosphate glass dosimeter and a readout device incorporating an ultraviolet radiation source are described. (B.G.D.)

707 APPARATUS FOR THERMALLY MEASURING ABSORBED RADIATION DOSES. Schleiger, Eugene R.; Goldstein, Norman (to Secretary of the Navy). U. S. Patent 3,394,258. July 23, 1968. Filed Feb. 19, 1965.

The apparatus includes a radiation absorber member carried in a chamber formed of a thermal heat shield, the temperature of the shield being maintained constant by being disposed in substantial thermal contact with a reservoir containing a cryogenic fluid, such as liquid nitrogen. To minimize undesired environmental temperature variations the shield chamber is evacuated. Also the reservoir is surrounded by evacuated space provided between the walls of an external casing and the reservoir. A driven windlass means permits the absorber to be drawn into thermal contact with the reservoir wall where the absorber temperature reaches that of the wall. Temperature sensing of external radiation doses to which the absorber member may be subjected is achieved by placing a thermistor in contact with the absorber and electrically coupling the thermistor to temperature recording means. A further feature lies in the physical arrangement of parts which enables complete portability. (auth)

708 THE PHYSICAL MEASUREMENT OF ACCIDENTAL GAMMA AND BETA IRRADIATION. POSSIBILITIES AND LIMITATIONS OF THE VARIOUS METHODS. Wachsmann, F. (Gesellschaft fuer Strahlenforschung m.b.H., Munich). pp 497-505 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

The various types of dosimeters which can be used for beta and gamma dosimetry during radiation accidents are discussed. These include ionization chambers, photographic film dosimeters, photoluminescent dosimeters, thermoluminescent dosimeters, and pocket dosimeters based on the principle of the x-ray element. (B.G.D.)

Radiometric Instruments

Refer also to abstract 1066.

709 A STUDY OF THE DESIGN PARAMETERS FOR THE MEASUREMENT OF CARBON BY NEUTRON INELASTIC SCATTERING. Fite, Lloyd Emery. College Station, Tex., Texas A and M Univ., 1968. 119p.

Thesis.

Research efforts to determine the feasibility of a neutron carbon meter using the technique of fast neutron inelastic scattering analysis are discussed. The principal objective was the rapid and precise determination of carbon in steel mill feed iron ore sinter mix. In order for the analysis to be commercially useful in a sintering plant, it has to be performed to high precision, in a brief period of time. The specific objective is to analyze an iron ore sinter mix containing approximately 6% carbon to within 0.25% carbon in two minutes or less. The evaluation of the feasibility of meeting the above requirements included the investigation of various types of neutron sources, neutron attenuators, scintillation detectors, and sample configurations. The results of the individual experiments are given in detail in the dissertation. The basic finding is, however, that the requirements as established, 6% ± 0.25% carbon within 2 minutes cannot be met using neutron inelastic scattering methods for the following reasons: (1) the carbon response from a sinter mix sample is hindered by the background continuum which is induced in the measurement by neutrons passing through the neutron attenuator and being scattered into the scintillation detector from the sample and the experimental environment, and the carbon response using neutron inelastic scattering is too small to achieve the desired precision and response time from an iron ore sinter mix sample containing 6% carbon. An inelastic scattering system for the carbon analysis of iron ore sinter mix which could be located in a sintering plant is described and the procedures by which the system was designed is discussed. The neutron carbon meter which was developed can analyze an iron ore sinter mix sample containing 10% carbon to within 0.25% carbon in 63 minutes. The system consists of a cone-shaped sample container which holds a 250 pound sinter mix sample, a 10 curie americium/beryllium neutron source, a 3″ × 12″ copper neutron attenuator, a 3″ × 3″ NaI(Tl) scintillation detector with a boron-10 thermal neutron shield, a pulse-height analyzer and a low energy gamma-ray discriminator circuit. The system which is relatively simple should be very reliable. This carbon meter does provide a faster analysis of the carbon content in iron ore sinter mix than was previously available using nuclear techniques, and includes specially developed circuitry for this purpose. (Disser. Abstr.)

710 ALPHA-PARTICLE THICKNESS GAUGE. Lewis, V. E. (King's Coll., London). Nucl. Instrum. Methods, 64: 293-6(Oct. 1968).

An alpha-particle thickness gage suitable for surface densities up to 12 mg/cm^2 is described. The energy loss of 8 MeV alpha-particles traversing target foils is related to surface density using simple empirical formulas derived from existing dE/dx data. (auth)

711 METHOD OF AND APPARATUS FOR DETERMINING THE MEAN SIZE OF GIVEN PARTICLES IN A FLUID. Carr-Brion, Kenneth Garfield (to National Research Development Corp.). British Patent 1,127,342. Sept. 18, 1968. Filed Mar. 28, 1966.

A method of determining the mean size of given particles in a fluid by the absorption of gamma or x radiation is described. (B.G.D.)

712 IMPROVEMENTS IN OR RELATING TO GAS IONISATION DETECTORS. Lovelock, James Ephriam (to W. G. Pye and Co. Ltd.). British Patent 1,131,932. Oct. 30, 1968. Filed Dec. 23, 1964.

A gas ionization chamber for determining the quantity of a gaseous impurity present in a gas is described. The chamber consists of an electrode of various configurations surrounding but electrically insulated from an electrically conducting member carrying an alpha or beta source. (B.G.D.)

713 DUAL COLUMN GAS CHROMATOGRAPHY APPARATUS. Bull, Hugh L. U. S. Patent 3,400,264. Sept. 3, 1968. Filed Sept. 1, 1964.

A gas chromatograph with an alpha source detector is described wherein direct ionization measurement is obtained. Electrodes are maintained at a positive voltage between 100 and 300 volts dc to accelerate the positive ions resulting from ionization by the alpha source toward collector electrodes which are maintained at a negative voltage between 100 and 300 volts dc. Electrodes maintain the alpha source at a positive voltage between 20 and 50 volts dc to attract electrons to the alpha source to assure ionization of the sample and to replace the charge of the alpha particles that emanate from the alpha source. (auth)

714 NON-DESTRUCTIVE EQUIPMENT FOR MEASURING THICKNESS. Ind. Tech., No. 101, 75(Jan. 20, 1968). (In French).

The Micro-Derm makes non-destructive measurements possible with direct reading as fine as a few millimicrons. Using this portable instrument, the thickness of metallic or non-metallic coatings can be measured on most materials, regardless of their shape and size. No special experience is needed to use this equipment, either in the laboratory, or on production control, since the thicknesses can be read directly without requiring any calculations. The Micro-Derm unit comprises a beta radiation source and a detector so located that the beam reflected on the surface of the material whose thickness is to be measured is intercepted by the detector and converted into an indication of the surface thickness. (Sum. Articles Fr. Tech. Press)

715 APPLICATION OF THE COULOMB BACKSCATTERING OF THE HEAVY CHARGED PARTICLES. I. THICKNESS MEASUREMENTS OF THIN FOILS AND SURFACE LAYERS. Turos, Andrezej (Inst. of Nuclear Research, Swierk, Poland); Wilhelmi, Zdzislaw. Nukleonika, 13: 976-97(1968).

A nondestructive method of investigating surface layers in which use is made of the phenomena occurring during backscattering of charged particles in the Coulomb field of the nucleus has been developed. The analysis of energy spectra of particles scattered at an angle of 165° renders the determination of the chemical composition and thickness of the sample investigated possible. Thickness measurements of surface layers and thin foils are discussed. The measurements performed, in which alpha-particles, ^{3}He-particles and deuterons with energies ranging from 1 to 3 MeV

were used, have shown that the thickness can be determined with an accuracy of about 5% if the thickness of the samples varies from 0.05 mg/cm² to 10 mg/cm². (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 424, 1553, 1768, 1991, 2053, 2154, and 2163.

716 (AD-671150) A HIGH-PRECISION LOGARITHMIC AMPLIFIER USING SAMPLING TECHNIQUES. Report No. Scientific-313. Simmering, Lawrence R. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). Dec. 1, 1967. Contract F-19628-67-C-0301. 39p. (AFCRL-68-0191. CFSTI.

An analysis and design of a versatile periodic sampling logarithmic amplifier is presented. The design uses the decay of a voltage in an RC network to generate a precise logarithmic response and employs the cascading of several stages to increase the dynamic range of the design. Accuracies greater than those obtained by the common approximation methods are obtained. (USGRDR)

717 (ARH-SA-19) ON-LINE COMPUTER AND DATA TRANSMISSION NETWORK SUPPORTING TWO NUCLEAR ANALYTICAL LABORATORIES. Johnson, W. C. Jr.; Kent, Roy A. R. (Atlantic Richfield Hanford Co., Richland, Wash.). Aug. 14, 1968. Contract AT(45-1)-2130. 18p. (CONF-680918-2). Dep. CFSTI.

From American Chemical Society Meeting, Atlantic City, N. J.

An on-line data retrieval and update system is described in supporting the analytical laboratories at ARHCO's Chemical Processing complex in Richland, Washington. Much of the repetitive-type work that is performed in the laboratories is handled by the computer system which incorporates queueing techniques and interrupt routines for servicing the many terminals. The computer is located in the analytical laboratory of one nuclear facility and classified lines connect the terminals located within this facility. Non-classified lines connect the computer to terminals in two other nuclear facilities which are geographically located 1.5 and 5.5 miles away. (auth)

718 (ORNL-4299) FLOTSAM: A TWO-PARAMETER ON-LINE DATA ACQUISITION PROGRAM FOR THE PDP-7. Marusak, A. L. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 107p. Dep. CFSTI.

FLOTSAM is a program for the PDP-7, designed to accept one- and/or two-parameter data from experiments. The two-parameter program used for measuring neutron cross sections by the time-of-flight technique from (d,n), (n,n'), and (p,n) reactions is described. Sufficient versatility is included so that conversion to one-parameter 4096-channel data acquisition or other configurations is, with some study of the program, easy anc has been done. The data from ADC's are fed directly into the computer into one of two 64-word temporary buffers. While one buffer is being filled with data, events in the other are being analyzed and stored. A bank of six scalers can be read into the computer and stored. A continuous oscilloscope display of all or some of the data is provided, with three modes (linear, log, square root) available for the y-coordinate (number of counts in a channel). Light pen routines are provided to enable one to extract peak information from either old data stored on magnetic tape or from data as they are taken. Permanent storage of data is on IBM-compatible magnetic tape; the data can also be typed out or plotted on a CALCOMP plotter. A general description of the program, operating instructions, some flow charts, and the complete annotated listing of the program itself are presented. (auth)

719 (SC-DC-68-2417) ELECTROMORPHIC CERAMICS IN EXTREME ENVIRONMENT PARAMETRIC DEVICE APPLICATIONS. EerNisse, E. P. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 28p. (CONF-681011-1). Dep. CFSTI.

From Applications of Ferroelectrics Symposium, Washington, D. C.

Diffuse-transition electromorphic ceramics were investigated for parametric device applications in extreme temperature and radiation environments. The circuit properties of nonlinear capacitors fabricated from such materials were found to be relatively constant over a temperature range of hundreds of degrees centigrade and extremely insensitive to nuclear radiation. Because of dielectric relaxation behavior, efficient parametric device applications are limited to below 10 MHz with presently available materials. An antiferroelectric composition provided more efficient parametric amplification at the higher frequencies than did the ferroelectric compositions investigated. (auth)

720 (UCRL-18166) SYSTEM OF FAST INTEGRATED CIRCUIT LOGIC FOR PHYSICS INSTRUMENTATION. Kirsten, Frederick A.; Mack, Dick A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1968. Contract W-7405-eng-48. 11p. (CONF-680906-6). Dep. CFSTI.

From International Symposium on Nuclear Electronics, Versailles, France.

Integrated circuits are finding an increasing number of applications as fast logic elements for high-energy physics experiments. A particularly important problem is to design a system of hardware for the integrated circuits that not only preserves their speed characteristics and provides flexibility of interconnections where necessary, but also preserves their great cost advantage when used to construct large systems of logic. A particular approach to the hardware problem is described. Groups of integrated circuits are assembled onto logic cards to form the logic modules most useful for physics instrumentation. Fast input and output connections are made by means of an inexpensive transmission-line connector used in conjunction with a commercially available card-edge connector. Power-supply voltages are chosen to make all logic levels NIM compatible. A particular example of a medium-scale logic array—a 36-channel hodoscope register—is given. (auth)

721 IMPROVEMENTS IN LIQUID LEVEL GAUGES. Neisse, Gerard; Elbaz, Jack; Metivier, Robert; Morbello, Mario (to EURATOM). British Patent 1,129,625. Oct. 9, 1968. Priority date Feb. 16, 1965, Belgium.

A pneumatic gage for measuring the level of a liquid moderator in the pressure vessel of an experimental nuclear reactor is described. A stream of gas from a supply conduit issues from a nozzle onto an impingement surface which moves toward and away from the nozzle with rise and fall of the liquid. The surface as it approaches the nozzle causes increasing restriction in the gas flow and increasing back pressure in the supply conduit. The impingement surface is constituted by a feeler operating in a discharge passage downstream of the nozzle. (W.H.K.)

722 DEVICE FOR DETERMINING LIQUID VOLUMES BY MEASUREMENT OF THE DILUTION OF A RADIO-ACTIVE SOLUTION. Leroy, Marcel; de Vernejoul, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,131,036. Oct. 16, 1968. Priority date Mar. 30, 1965, France.

A device suitable for use in determining liquid volumes by measurement of the dilution of a radioactive solution is described. It is composed of a scintillation or other radiation detector, fixed sample-reception means, movable sample-reception means, and an adjustable mounting by means of which the distance between the movable sample-reception means and the means to detect and measure the radiation can be varied. (W.H.K.)

723 MAGNITUDE OF PULSE-RATE CHANGES IN FLUCTUATIONS OF A γ-MONOCHANNEL MEASUREMENT SETUP. Potschwadek, B. (Univ., Rostock, Ger.). Atompraxis, 14: 402-5 (Sept.-Oct. 1968). (In German).

The results of a previous publication made it possible to give the pulse-rate error caused by fluctuations in channel position or width. It is assumed that the γ-peak is approximated by a Gaussian distribution, and that the Sheppard correction is valid. (auth)

724 A FLYABLE MASS SPECTROMETER USING THE SPATIALLY PERIODIC STATIC FIELD. 1. Fugono, Nobuyoshi; Aikyo, Kazuhiro Denpa Kenkyusho Kiho, 14: 368-72(May 1968). (In Japanese).

The application of a spatially periodic static field for mass analysis is examined. A flyable mass spectrometer of new configuration using the spatially periodic static field is proposed. Equations of motions for ions in the spectrometer are derived under reasonable conditions. Furthermore, there are shown trajectories of ions calculated by a computer under a typical operating condition. These results demonstrate the possibility that the mass spectrometer of this configuration is utilized for measuring the composition of the upper atmosphere. (auth) (NSA of Japan)

725 FAST ELECTRONICS. Bull. Instrum. Nucl., No. 33, 1-62(1968). (In French).

The general characteristics of fast electronic circuits are outlined and discussed. The fast electronic elements available in 1968 are tabulated. The particular characteristics of available electronic circuits are given. The circuits described are amplifiers and preamplifiers, amplitude discriminators, distributor and mixer, coincidence, logic, delay, attenuators, converters, and gating circuits. Some applications of these circuits to the measurement of the lifetimes of excited nuclear states and to the measure-

ment and identification of particles in a high-energy unseparated beam are described. (J.S.R.)

726 BULLETIN INSTRUMENTATION NUCLEAIRE. NUMBER 34. Bull. Instrum. Nucl., No. 34, 1-43(June 1968). (In French).

An oriented programmed system for use in nuclear instrumentation is under development. The technical objectives are outlined with emphasis on the cost/performance compromise. The characteristics of the computer to be used are summarized and the preliminary specifications of the system are given. The characteristics and performance of other nuclear instrumentation recently developed are reported. The instruments described are the pulse integrator MTI 10, a CsI(Na) detector, new counting scalers, rapid printout 212 I.E.R., subassembly for temperature measurements, assembly for the measurement of ^{235}U enrichment, multimode γ spectrometer, monochannel selector designed for the detection of ^{131}I, numerical analog integrator, calculator of carbon dioxide output, programmer of the coolant water output of the Cabri power reactor, β-γ bridge contamination monitor, and the Pu data accumulation center. (J.S.R.)

727 IN-PILE MEASUREMENT OF CREEP AND STRESS-RUPTURE PROPERTIES OF MATERIALS. Middlebrook, H.; Tilbe, H. E. Reactor, 6: No 3, 19-22([1968]).

The development of methods of precision in-pile measurements based on a pneumatic gauging system is reported. The equipment is illustrated, and in-pile creep experiments on Zircaloy, designed for maximum stresses of 50,000 psi at 280 to 350°C and nuclear heating rates of 2 w/g, are described. A modified pneumatic gauge with good sensitivity at large extensions was devised for stress-rupture experiments, and interim results from a prototype rig currently undergoing irradiation are illustrated by curves. New designs for application at higher temperatures, stresses, and neutron fluxes are being developed. (UK)

728 APPLICATIONS OF THE FACING-COUPLED ESAKI DIODE PAIR. Murata, Y. (Musashi Inst. of Tech., Tokyo). Nucl. Instrum. Methods, 64: 349-55(Oct. 1968).

Circuits for radiation instrumentations utilizing the FCED (facing coupled Esaki diode) pair have been investigated experimentally. The circuits developed for trial purposes are as follows: a voltage comparator with very small hysteresis; a majority logic circuit having memory action; a simple flip-flop circuit consisting of passive elements; a normalizing circuit to normalize the input to a time position synchronizing with a clock signal; a variable-width coincidence circuit which can continuously and accurately vary coincidence time width; and a shift register circuit with a very wide range of shifting interval. Subsequently, it was confirmed that these circuits applying the FCED principle work quite well and are of practical use. Further, in the case of an on-line experiment using a computer treating random phenomena, as in radiation instrumentation, these circuits serve as a good converter between the experimental system and the computer. (auth)

729 LABORATORY DEBYE-SCHERRER CAMERA USING AN ^{55}Fe SOURCE OF Mn K_α X RAYS. Bugenis, C.; Preuss, Luther E.; Toothacker, William S. (Edsel B. Ford Inst. for Medical Research, Detroit). Rev. Sci. Instrum., 39: 1754-5 (Nov. 1968).

The camera and the experimental conditions in the first successful Debye-Scherrer work with cyclotron-produced iron-55 x-ray sources are described. (W.H.K.)

730 TRANSIENT VOLTAGE DECOUPLING ELEMENTS. Gruber, J. E. (Institut fuer Plasmaphysik, GmbH, Garching, Ger.). Rev. Sci. Instrum., 39: 1740-3(Nov. 1968).

Premature and inexact timing of thyratron generators may occur during parallel operation of capacitor discharge circuits. Voltage transients which enter the trigger circuits can be eliminated by decoupling spark gaps. A simple, two electrode, spark gap with corona illumination is described. The low jitter of this gap allows its insertion in the output line of a 15 kV thyratron generator without changing the output performance of the generator. (auth)

731 PROBE FOR DETECTION OF VOIDS IN LIQUID METALS. Chen, John C.; Kalish, Sheldon; Schoener, George A. (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 39: 1710-13(Nov. 1968).

A probe was developed for detection of vapor or gaseous voids in liquid metals. With a sensing element of ≈0.5 mm diam, it is possible to obtain indications of point conditions. Probe response is of the order of 1 msec to a step change from liquid to void or vice versa. The probe is suitable for use in liquid metals at temperatures up to 900°C. (auth)

732 X-RAY SPECTROGRAPHIC CAMERA. Koenig, Jude H.; Schoeffel, James A.; Carron, Gene J. (McDonnell Co., St. Louis). Rev. Sci. Instrum., 39: 1635-8(Nov. 1968).

Polaroid film records of the x-ray spectral range 0.5 to 7Å are obtained with a compact x-ray spectrographic camera. Samples ranging in size from virtually any bulk specimen to those of microgram quantity can be analyzed nondestructively. The camera operates with either x-ray spectrographic or x-ray diffraction tubes and requires analysis times of 1 to 60 min. (auth)

733 ANALYSIS OF RANDOM AMPLITUDE NANOSECOND PULSES. Adin, A. (Israel Atomic Energy Commission, Tel-Avi). Nucl. Instrum. Methods, 64: 328-32(Oct. 1968).

A combination of a sampling unit and a modified multichannel analyzer is described. The system is used to analyze nanosecond pulses of constant shape whose amplitude changes randomly. The sampling unit provides fast response and high sensitivity, while the multichannel analyzer computes, displays and prints a digitally analyzed mean pulse thereby eliminating noise. The accuracy of the mean pulse increases statistically with the number of sampling sweeps. The jitter in the triggering of the sampling unit due to the spread in the amplitude of the analyzed pulses is reduced by using the zero crossing technique. The risetime and linearity of the system are limited by the characteristics of the sampling unit, as the multichannel analyzer accumulates the information with an accuracy better than one percent. The system may also be used for fast digital analysis of constant amplitude pulses, for gain measurement of photomultipliers (in the range of 10^8) and similar applications, and hence constitutes a useful laboratory instrument. (auth)

734 NEW DESIGN FOR A LIQUID HELIUM POLARIMETER. Birchall, J.; Kenny, M. J.; McKee, J. S. C.; Reece, B. L. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 65: 117-18 (Oct. 15, 1968).

A new design for a liquid helium polarimeter is presented in which a photomultiplier is mounted vertically above the liquid, and directly coupled to it. (auth)

735 MAGNETIC AMPLIFIER FOR LOW-LEVEL INPUT SIGNALS. Inose, Fumiyuki; Morozumi, Hiroshi; Suda, Kyo; Numakura, Toshio; Mori, Ryutaro. (to Kabushiki Kaisha Hitachi Seisakusho). U. S. Patent 3,402,359. Sept. 17, 1968. Priority date July 13, 1963, Japan.

A magnetic amplifier having a single core and a gating switch connected in the gate winding circuit which provides a push-pull characteristic for low-level input signals is described. (auth)

736 GLIDE PATH APPROACH SYSTEM FOR LANDING AIRCRAFT UTILIZING NUCLEAR RADIATION. Campanella, Angelo J. (to Industrial Nucleonics Corp.). U. S. Patent 3,403,254. Sept. 24, 1968. Filed Apr. 6, 1964.

A system for providing flight information during landing of an aircraft is described. At least two radiation sources are positioned on the landing approach to form a region of intersecting radiation along a predetermined glide path. Instrumentation is mounted on the aircraft for indicating the position of the aircraft in vertical and horizontal planes. (W.H.K.)

737 ADVANCES IN MASS SPECTROMETRY. VOLUME 4. Proceedings of Conference Held in Berlin, Sept. 1967. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968. 987p. 160s.

This Conference was organized by a joint committee of ASTM E-14, the Hydrocarbon Research Group of Institute of Petroleum, A. G. Massenspektroskopie der DPG, and GAMS. Eighty-three presented papers and discussions under the following sectional headings are reproduced: Data acquisition and processing in mass spectrometry; mass spectrometry of organic compounds; ion-molecule reactions; inorganic quantitative analysis; theory of mass spectrometry; chemical ionization; elementary processes; photon impact; field ionization mass spectrometry; space mass spectrometry; and nuclear physics. A list of papers presented at extra and parallel sessions is also included. Separate abstracts have been prepared for three papers. One paper was previously abstracted in NSA 21: 39286. (UK)

For abstracts of individual papers see: 738-740.

738 MASS SPECTROMETER FOR THE ISOTOPIC OXYGEN ANALYSIS OF WATER. Majzoub, M.; Nief, G. (CEN de Saclay, Gif-sur-Yvette, France). pp 511-20 of Advances in Mass Spectrometry. Vol. 4. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968.

From 4th International Conference on Mass Spectroscopy, Berlin. See CONF-670920.

A mass spectrometer was designed for the measurement of the isotopic oxygen ratio $^{18}O/^{16}O$ of water without any previous chemical operations. Liquid water is injected and vaporizes in the gas

line of the apparatus. Measurements are performed on the ion peaks at mass 18 ($H_2\ ^{16}O^+$) and 20 ($H_2\ ^{18}O^+$) of the mass spectrum of the water vapor. Memory effect and source corrosion were investigated. Memory effect is practically suppressed by the use of a double Pyrex capillary introduction line emerging directly into the ionization chamber and by heating the whole apparatus to about 150°C. Corrosion is avoided by using ion chamber elements made exclusively from copper. The electron emitting filament is made of tungsten or rhenium. In the natural concentration range the general performance is as follows: quantity of water necessary for one analysis, 10 mg; time required for one analysis, 20 minutes; and reproducibility for an individual measurement, $\sigma = 0.08\ \delta$ unit where δ is $[(^{18}O/^{16}O)_{sample}/(^{18}O/^{16}O)_{standard} - 1] \times 1000$. (auth) (UK)

739 DATA HANDLING IN PRECISE ISOTOPE RATIO RESEARCH. Nielsen, Heimo (Zentrallaboratorium fuer Geochemie der Isotope, Goettingen, Ger.). pp 267-74 of Advances in Mass Spectrometry. Vol. 4. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968.

From 4th International Conference on Mass Spectroscopy, Berlin. See CONF-670920.

The data handling system in use for four years at the Göttingen laboratory is described. This system involves digitalization of the mass spectrometer output signals, computer evaluation of the δ values conventionally used, and printing of data tables or of frequency analysis diagrams. This enables use to be made of all the data available from previous work in a manner hitherto completely impracticable. So far as spectrometer laboratories have adapted computer evaluation, their results are stored in a form suitable for other computers. Thus an interlaboratory circulation of copies of these data carriers will enable all laboratory groups working in the same field to bring their data lists up to date. (auth) (UK)

740 SIMPLE PEAK HEIGHT DIGITIZER OF ISOTOPIC MASS SPECTRA. Carre, J. C.; Bir, R.; Frejaville, G. (CEA, Paris). pp 275-86 of Advances in Mass Spectrometry. Vol. 4. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968.

From 4th International Conference on Mass Spectroscopy, Berlin. See CONF-670920.

The characteristics and main performance of a simple device for digitizing information supplied by a mass spectrometer are described. The principle of the apparatus lies in the scanning of the spectrum by a periodic saw-tooth variation of the magnetic field. The output of the spectrometer is coupled to a voltage-frequency converter. The pulses emitted during equal time intervals are stored in a multi-channel selector, in such a way that the number of pulses registered in each channel represents the amount of electric charge collected in the mass region [M, M + ΔM]. The analytical procedure is described and the main results obtained are given; these compare favorably with those supplied by graphical recorders. (auth) (UK)

741 APPARATUS FOR NEUTRON SELECTION BY MEANS OF A ROTATING SWITCH ROTOR. Will, Walter; Geist, Heinz; Krebs, Karlheinz (to EURATOM). British Patent 1,131,541. Oct. 23, 1968. Priority date Apr. 12, 1965, Germany.

A neutron chopper is described which has a switch rotor that is driven by an electric motor and is freely suspended by a flexible shaft from the shaft of the electric motor. The upper end of the motor shaft bears means for producing a phase-angle signal. At the lower end of the rotor there is centrally located a pivot which extends loosely into a liquid-damper support. (B.G.D.)

742 NAVIGATIONAL SYSTEM EMPLOYING NUCLEAR RADIATION GLIDE PATHS. Campanella, Angelo J. (to Industrial Nucleonics Corp.). U. S. Patent 3,403,255. Sept. 24, 1968. Filed June 9, 1964.

A beacon is positioned adjacent a landing area to radiate beams of nuclear radiation upward in the direction of a glide path to the landing area. The beams have different predominant energies and are spaced along the glide path to form a region of commingled radiation energies with a region to one side having only one of the predominant radiation energy ranges and a region to the other side having only the other predominant radiation energy range. The aircraft is equipped with means for detecting the radiation to indicate the position of the aircraft. (W.H.K.)

743 X-RAY SPECTROMETRY APPARATUS HAVING BOTH INTERCHANGEABLE SPECIMENS AND RADIATION SOURCES. Houbart, Yvan (to Centre National de Recherches Metallurgiques). U. S. Patent 3,400,265. Sept. 3, 1968. Priority date Apr. 1, 1964, Belgium.

An apparatus is described for examining a specimen by bombardment with radiation, which apparatus includes a stationary base plate with an aperture therein for accommodating a radiation source and a rotatable turret mounted over the base plate, with at least two specimen holders therein, and means for evacuating the aperture, in which the aperture has an open upper end and a closed lower end, provision being made for at least one source of radiation to be introduced into the said aperture through the side walls thereof. (auth)

744 TIME-OF-FLIGHT MASS SPECTROMETRY APPARATUS HAVING A PLURALITY OF CHAMBERS WITH ELECTRICALLY RESISTIVE COATINGS. Gohlke, Roland S.; Karle, Franklin J. (to Dow Chemical Co.). U. S. Patent 3,394,252. July 23, 1968. Filed Dec. 4, 1964.

An electrostatic time-of-flight mass spectrometer apparatus is described in which a ribbon of electrons is brought to sharp focus along the longitudinal axis of the ion source and ion acceleration and flight tube assembly. The ions produced by the collision of the electron beam with the sample in the ion source are accelerated by means of substantially uniform accelerating fields through collimating slits in the ion source, ion accelerator, and flight tube and impinge on a detector which usually is an electron multiplier device. (auth)

745 MULTI-CHANNEL PULSE HEIGHT ANALYZER USING MULTISTAGE DELAY LINE MEMORY SYSTEMS. Takaba, Sadao; Moriwaki, Yoshio. (Tokyo Univ.). Seisan-Kenkyu, 20: 259-65 (June 1968). (In Japanese).

With the purpose of increasing the counting rate of a multichannel pulse height analyzer using delay line memory systems for the measurement of radiation-energy distributions, a scheme, which employs a combination of two or three delay lines of different lengths, was devised. The scheme itself, and also the results of characteristics analysis, are described. It is shown that with the multistage memory system the counting rate can be increased greatly. (NSA of Japan)

746 REACTOR INSTRUMENTATION. Macleod, C. J. (Univ. of Strathclyde, Glasgow). Meas. Instrum. Rev., 15: 741-4(Oct. 1968).

A survey is made of the instrumentation likely to be required by four types of reactors which may, in the future, supersede the graphite-moderated, gas-cooled reactors used at present by the Central Electricity Generating Board of UK. The information is presented in tabular form, the reactors considered being AGR, fast reactors, water reactors, and fluid fuel reactors. (auth)

747 NEW TYPE OF FAST PULSE LIMITER WITH A CORRECTOR FOR DELAY. Looten, A. (CERN, Geneva). Nucl. Instrum. Methods, 65: 205-12(Nov. 1, 1968). (In French).

A circuit is described which permits the limiting of fast pulses, e.g., 2 ns to good precision, ±100 ps, over a wide range of pulse height, e.g., 3 to 50 V and at high counting rate (average separation 7 ns). (auth)

748 STACKING REGISTER: SIMULTANEOUS INPUT/OUTPUT BUFFER. Philokyprou, G.; Zacharacopoulos, A. (Demokritus Nuclear Research Center, Athens). Nucl. Instrum. Methods, 65: 202-4(Nov. 1, 1968).

A simultaneous input/output buffer register, called the stacking register, is described. Each word accepted by this register is stacked at its other end from where it can be transmitted to the acceptor. This can buffer data from a random source of information with instantaneous frequency higher than that of an acceptor but with average frequency equal or smaller than the average frequency of the acceptor. The logic of the stacking register and its control unit is given. The relation between the length of the stacking register and the input and output frequencies is derived. (auth)

749 SIMULATION OF ONE-DIMENSIONAL COUNTING SPECTRA. Wenzelburger, H. (Univ., Frankfurt am Main). Nucl. Instrum. Methods, 65: 199-201(Nov. 1, 1968).

Two methods are described to generate synthesized statistical data in a Fortran program. The first is a standard method in Monte Carlo work, suited for data, grouped owing to their origin. The second method developed turns out to be more effective in saving computer time. Both methods are only applicable to one-dimensional distribution functions. (auth)

750 EFFECT OF TEMPERATURE AND PRESSURE ON THE MOSAIC SPREAD IN A Ge MONOCRYSTAL. Konstantinovic, J.; Zivanovic, M.; Davidovic, M. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Instrum. Methods, 65: 233-4(Nov. 1, 1968).

An increase in mosaic spread was measured by the rocking-curve method, using slow neutrons of $\lambda = 1.884$ Å, reflected by Ge(III). The warming-up of a Ge monocrystal to 700°C followed by a sudden cooling-down to room temperature, while holding up the pressure at 15 atm shows an increase in mosaic spread of 7 min. (auth)

751 FAST PULSE AMPLITUDE-TO-TIME CONVERTER FOR AN EQUIVALENT CLOCK RATE OF SOME GHz. De

Lotto, I. (CNR, Milan. Univ., Bologna); Manfredi, P. F.; Maranesi, P.; Vaghi, F.; Vecchio, R. Nucl. Instrum. Methods, 65: 228-32(Nov. 1, 1968).

A very fast pulse amplitude-to-digital converter has been realized connecting a sampling height-to-time converter to a digital time sorter. Very good differential linearity and encoding accuracy have been obtained with an equivalent clock frequency of some GHz. (auth)

752 DISCRIMINATOR AND LOW LEVEL GATE. Meynadier, C.; Kamert, J. C. (Institut d'Etudes Nucleaires, Algiers). Nucl. Instrum. Methods, 65: 183-8(Nov. 1, 1968). (In French).

A low-level linear gate and the associated discriminator are described. These units are used in a detection channeling equipment and permit to keep, after the mixture, the resolution obtained at the charge-preamplifier level. (auth)

753 LOW-RESISTANCE VOLTAGE DIVIDER FOR PHOTOMULTIPLIER. Jung, H.; Bruellmann, M. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Instrum. Methods, 65: 178-82(Nov. 1, 1968). (In German).

The stability of a photomultiplier at high counting rates requires the use of a low-resistance voltage-divider for the last few dynodes. This has been realized by means of a transistor circuit which stabilizes the potentials of the last three dynodes by comparison with the corresponding potential of an unloaded resistance voltage-divider. The dynode voltages can thus be varied over a wide range. The temperature dependence of the elements has been practically eliminated by means of a symmetrical circuit design. (auth)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 1514.

754 (BNWL-SA-1658) RADIATION INDUCED CURRENTS IN CABLES. Bourassa, Ronald R.; Stringer, James L.; Dau, Gary J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 7, 1968. Contract AT(45-1)-1830. 5p. (CONF-680601-38). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The problem of currents induced in a coaxial cable was studied. An equation is given for the currents from gamma-ray absorption by photoelectric and Compton processes. Experiments were carried out in a ^{60}Co gamma source and a TRIGA reactor. The current was negative and proportional to the dose rate in the gamma source, while both negative and positive currents were induced in the reactor. The bulk conductivity of the MgO insulator was also measured. (D.L.C.)

755 (N-68-26662) EFFECTS OF NUCLEAR RADIATION ON A HIGH-RELIABILITY SILICON POWER DIODE I: CHANGE IN I-5 DESIGN CHARACTERISTICS. Been, Julian F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1968. 37p. (NASA-TN-D-4620). CFSTI.

Tests were conducted on 100 diodes in the NASA Plum Brook Reactor facility, which was designed to simulate a SNAP-8 nuclear environment. The diodes were irradiated in different operational and temperature modes for approximately 480 hr, with a resultant diode exposure to a total fast-neutron fluence (energies of 0.1 MeV and above) of 5×10^{13} neutrons/cm^2 and to a total gamma dose of 3×10^7 RADS (C). Results showed that this diode could be reliably used in a nuclear electric generating system such as SNAP-8 provided that the total radiation levels were within those of the tests. No catastrophic failures occurred. The electrical characteristic that would limit the useful lifetime of the device with increased radiation is the forward voltage drop at high current levels. (auth) (STAR)

756 (N-68-27203) HIGH ENERGY PROTON TESTING OF MARINER 4 COMPONENTS. Anspaugh, Bruce E. (Jet Propulsion Lab., Pasadena, Calif.). Jan. 1, 1967. Contract NAS-7-100. 35p. (NASA-CR-95148; JPL-TM-33-314). CFSTI.

The following Mariner 4 components were irradiated with 20- to 137-MeV protons from the Harvard synchrocyclotron: Canopus tracker, data encoder, squibs, batteries, solar cells, central computer and sequencer circuitry, sun sensor, and semiconductor devices and integrated circuits. Flux rates used varied between 5×10^4 and 3×10^7 protons/cm^2 sec. All tested units were irradiated to an integrated flux of at least 2×10^{10} protons/cm^2. All components, except the solar cells and Canopus tracker, operated normally during irradiation. The power output of the solar cells permanently dropped to approximately 85% of the pre-irradiation value but was less than the predicted power loss. The tracker lost roll control at flux rates greater than 6×10^5 protons/cm^2 sec for energies greater than 40 MeV, but recovered tracking ability immediately when the beam cut off, even after an integrated flux of 2.4×10^{10} protons/cm^2. Consequently, a high energy, high intensity solar flare could degrade tracker operation to a marginal region, but the system will recover after the flare. The tracker sensitivity was found to be due to an induced radioactivity in the image dissector tube. (auth) (STAR)

757 (N-68-27307) PHENOMENOLOGICAL STUDY OF RADIATION DAMAGE AND RECOVERY OF METAL-OXIDE FIELD EFFECT TRANSISTORS. Desai, U. D.; Van Allen, R. L.; Wolfgang, J. L. Jr. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). [1966]. 13p. (NASA-TM-X-5752; CONF-660705-15). CFSTI.

From IEEE Annual Conference, Palo Alto, Calif.

Radiation damage and modes of the recovery process of metal oxide field effect transistors are investigated. Only p-channel enhancement mode devices were studied and the source of radiation was a 1.5 MeV electron beam. All samples tested were first damaged with irradiation and then their electrical characteristics recovered by either thermal annealing through four cycles, or by heating to a temperature (280°C) so that even at zero gate voltage the unit was saturated and current between drain and source was limited with external resistance to 100 μA. Most of the observations in this study of degradation and recovery could be explained on the basis that ions are trapped in the surface states at the interface of Si and SiO_2. These ions are generated by the radiation in the SiO_2, migrate and become trapped in these surface states. Further, the ions are relatively immobile and counteract the field applied at the gate electrode which is attempting to form the channel. (STAR)

758 (N-68-27456) EFFECTS OF DAMAGE BY 0.8 MeV-5.0 MeV PROTONS IN SILICON SURFACE-BARRIER DETECTORS. Coleman, J. A.; Love, D. P.; Trainor, J. H.; Williams, D. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1968. 39p. (NASA-TM-X-63242; X-611-68-221). CFSTI.

Changes in the performance of silicon surface-barrier detectors after irradiation with protons at energies between 0.80 MeV and 5.00 MeV have been investigated for fluences up to 10^{17} protons cm^2. Irradiations of the front, surface-barrier contacts and the rear, ohmic contacts of these transmission detectors were performed. In general, the detector current and noise increased with fluence. When the rear, ohmic contact was irradiated with protons which stopped within the detector, the changes in the current and noise after irradiation were several orders of magnitude smaller than after a similar irradiation of the front contact. For protons with energies greater than about 1 MeV, the detector capacitance decreased at low reverse biases and increased at high biases with increasing fluence. The results indicate that a significant reduction in the increase of detector current and noise can be obtained if the density of radiation-produced defects in the region of the junction is minimized. (auth) (STAR)

759 (N-68-27541) SOLAR CELL RADIATION EXPERIMENT ON THE EXPLORER 23 MICROMETEOROID SATELLITE. Ellis, Walter E.; Bene, James (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1967]. 28p. (NASA-TM-X-60138). CFSTI.

The presence of energetic electrons and protons trapped in the earth's magnetic field presents a hazard to man's exploration of space, both to personnel in manned missions, and to certain materials and components used in the construction and operation of the spacecraft. Solar cells, widely used on spacecraft to convert sunlight to electrical power, are particularly vulnerable to these energetic particles. Transparent shields are almost universally used in solar cell space power systems to provide some protection from particulate irradiation. Weight considerations, however, often limit the amount of shielding that can be effectively employed. The objective of the solar cell radiation damage experiment on the Explorer XXIII satellite was to determine the effects of particulate irradiation on the performance of shielded and unshielded silicon solar cells while operating in the near-earth environment. This was accomplished by monitoring their output voltages while they were operating in space into fixed resistive loads, and comparing the results with initial voltages obtained from ground calibrations, and from flight data received soon after injection into orbit. (auth) (STAR)

760 (N-68-28846) STUDY OF THE EFFECT OF SPACE RADIATION ON SILICON INTEGRATED CIRCUITS. VOLUME 1. Final Report, April 10, 1967-April 9, 1968. Palkuti, L. J.;

Thatcher, R. K.; Elliott, K. E. (Battelle Memorial Inst., Columbus, Ohio). Contract NAS5-10308. 318p. (NASA-CR-95679). CFSTI.

Ten types (approximately 500 individual units) of both analog and digital integrated circuits were exposed to 0.5, 1.0, and 1.5 MeV electrons. In addition, seven different equivalent 962 circuits were exposed to 1.5 MeV electrons. The effects of radiation were determined in terms of the device behavior from both in situ measurements and more comprehensive pre/post characterization measurements. The circuits were mounted on circuit boards and were swept with an electron beam from a Van de Graaff generator. The irradiation was continued until either 50 percent failures were observed or a fluence of 1×10^{16} e/cm^2 was reached. The failure criterion for this program was any parameter exceeding the limit specified by the manufacturer. Generally, the purposes of this program were to obtain information that would give a better understanding of the effects of electron irradiation on semiconductor integrated circuits and to provide the necessary facts on which design decisions could be based. (STAR)

761 (N-68-28996) CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS. 13. EFFECT OF LITHIUM IN IRRADIATED SILICON. Final Technical Report, January 27, 1967-May 27, 1968. (TRW Systems Group, Redondo Beach, Calif.). May 25, 1968. Contract NAS5-10322. 74p. (NASA-CR-95735; TRW-10971-6002). CFSTI.

An experimental program has been conducted to evaluate the effects of electron irradiation on lithium solar cells. Considerable progress has been made in optimizing the technique of diffusing lithium into the devices and selecting starting materials. The best lithium cells compare favorably with n/p solar cells in an electron environment. The lithium cells are significantly superior to n/p solar cells under fast neutron bombardment. Capacitance measurements were used to study lithium distributions and concentration changes under different thermal conditions. The recovery kinetics were re-examined and the experimental evidence supports first order behavior for the case of the lithium concentration much greater than the defect concentration. Other miscellaneous studies were done to evaluate the effect of different dopants on radiation resistance of silicon. (STAR)

762 (N-68-29436) PHOTOVOLTAIC PROPERTIES OF U. S. AND EUROPEAN SILICON CELLS UNDER 1-MeV ELECTRON IRRADIATION. Cherry, William R.; Statler, Richard L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1968. 26p. (NASA-TM-X-63272; X-716-68-204). CFSTI.

The procedures and results of a project to determine the electron radiation effects on silicon solar cells are presented. Samples of U. S. and European cells were irradiated by means of Van de Graaff generators, and the I-V curves were determined to reveal the effects of the radiation. Data on maximum power and power at 0.35 volt for each cell irradiated are given. Comparison of the various cells and their associated radiation effects is facilitated by the inclusion of open-circuit voltage and short-circuit current data in tabular form. (STAR)

763 (N-68-29516) STUDY OF THE EFFECT OF SPACE RADIATION ON SILICON INTEGRATED CIRCUITS. PHASE 3. VOLUME 2. Final Report, April 10, 1967-April 9, 1968. Palkuti, L. J.; Thatcher, R. K.; Elliott, K. E. (Battelle Memorial Inst., Columbus, Ohio). Contract NAS5-10308. 278p. (NASA-CR-95676). CFSTI.

Characterization plans for the eleven amplifier and digital circuits types are presented. The plans include a schematic of the circuit studied along with common test conditions and a listing of tests performed, tested parameters and conditions of testing, and the specific schematics and test procedures for each test. The schematic diagrams and information concerning the procedures used in monitoring the behavior of the circuits during exposure to the electron radiation environment are delineated, and the results of pre/post irradiation measurements that were made according to the plans are given. Also included is a print-out of the computer programs used to tabulate, summarize, and plot the raw data. (STAR)

764 (N-68-30248) RADIATION EFFECTS ON LASERS. Final Report, July 1, 1965-October 1967. Compton, D. M. J. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 1, 1967. Contract NAS12-32. 80p. (NASA-CR-86068; GA-8238). CFSTI.

A continued program designed to study the effects of space radiation on lasers and to develop the background knowledge needed for the possible application of laser systems in a space environment is reported. The effects of radiation are described for two main types of lasers, gallium arsenide laser diodes, and optically pumped lasers such as ruby and neodymium in various host materials. Results indicate that neither type of laser is affected by doses and dose rates of space radiation suitable for manned space flight; for more severe environments, e.g., flights spending a large fraction of their time in the trapped radiation belts or with reasonably shielded on-board nuclear power, it is possible to select laser types which will be only minimally affected and whose performance can be restored by an annealing process; and for very severe environments e.g., near on-board nuclear power, it is at least possible to set certain guidelines relating to the effects to be expected. (STAR)

765 COMPENSATING TECHNIQUES FOR REDUCING THE RESPONSE OF TRANSISTOR CIRCUITS IN A TRANSIENT RADIATION ENVIRONMENT. Davis, Goebel Jr. Albuquerque, N. Mex., Univ. of New Mexico, 1968. 229p.

Thesis.

It would be desirable to be able to design transistor circuits which have no response, or a greatly reduced response, to pulses of transient gamma radiation. Several possible methods of reducing the effects of this radiation in transistor circuits are examined. The primary emphasis is upon the addition of back-biased junctions at selected circuit points. During irradiation, these extra back-biased junctions produce primary photo-currents which can be utilized to cancel or to compensate out the transient radiation responses of the original circuit. Approximating-equivalent circuits are developed for various circuits and methods of junction compensation. Utilizing these models, theoretical predictions are made for the resulting peak value circuit responses during irradiation. Engineering-design hardening criteria in the form of approximate mathematical equations are also developed which show the required relationships between the circuit and device parameters. The compensated amplifier circuits analyzed were: (a) common emitter, (b) common base, (c) common collector, (d) common base driving a common collector, (e) common emitter driving a common emitter and (f) common emitter driving a common collector. Additionally, some of the circuits were analyzed for transient-radiation response utilizing the CDC 6600 digital computer and the CIRCUS circuit analysis program. Certain selected hardened circuits were fabricated and experimentally tested under irradiation at the Kirtland Air Force Base Flash x-ray facility. These experimental results are compared to the theoretical and computer-predicted responses. The amplifier circuits experimentally tested were: (a) common emitter, (b) common base, (c) common collector, (d) common base driving the common collector, (e) a three transistor ac-coupled video amplifier, (f) a three transistor dc-coupled amplifier, and (g) a monostable flip flop. Of the numerous compensation techniques analyzed by the computer, theoretically evaluated, and experimentally tested, the use of a compensation junction in the base-to-collector circuit of an active transistor appears to be the most practicable. Using this technique, with good design and for certain bias regions of operation, the peak magnitude of the transient radiation response of an amplifier usually can be reduced by a factor of about 3 to 1 to 10 to 1 for radiation levels at least up to approximately 0.5×10^{10} R/sec. For nonlinear circuits, even higher radiation resistance levels than 0.5×10^{10} R/sec should be achievable by overcompensating if pulse outputs of certain polarities are not considered a system failure. (Disser. Abstr.)

766 NUCLEAR RADIATION DOSE RATE INFLUENCE ON THERMOCOUPLE CALIBRATION. Dau, Gary J.; Bourassa, R. R.; Keeton, S. C. (Battelle Memorial Inst., Richland, Wash.). Nucl. Appl., 5: 322-8(Nov. 1968).

The instantaneous effects of nuclear radiation on thermocouple calibration were measured using Chromel-Alumel and iron-Constantan thermocouples. Emf shifts of 2 to 4°C were found at radiation levels of 10^{16} n cm^{-2} sec^{-1} (fast and thermal) and 10^{10} R/hr. These emf changes were attributed to local gamma heating of the thermocouple bead rather than to a change in the thermoelectric power of the thermocouple materials. In separate experiments no transient changes were noted in thermocouple calibration (±1.0°C) following a change in radiation level of up to 7×10^{12} n cm^{-2} sec^{-1} (thermal and fast) and 7×10^6 R/hr. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 815, 897, 904, 909, 927, 933, 952, 959, and 1728.

767 (ACRH-1000-67) SOME STUDIES OF ERYTHROID DIFFERENTIATION IN VITRO. Goldwasser, Eugene; Gross, Martin (Argonne Cancer Research Hospital, Chicago, Ill. Chicago Univ., Ill. Dept. of Biochemistry). June 9, 1968. Contract AT(11-1)-69. 16p. (CONF-680635-1). Dep. CFSTI.

From Symposium of the Tissue Culture Association, San Juan, Puerto Rico.

Bone marrow cells were removed from femurs and tibias of rats for studies on hematopoiesis. Tracer techniques using ^{14}C, ^{59}Fe, and tritium were employed. When the cells were pre-incubated for periods of up to 20 days they retained the capacity to respond to exogenous erythropoietin. This was true whether the response was measured in terms of increased rates of RNA synthesis, protein synthesis, iron uptake, or hemoglobin synthesis. The patterns of response to erythropoietin by pre-incubated cells are complex and involve secondary waves of increased rates of synthesis that are not yet understood. (H.L.W.)

768 (ACRH-1000-80) STUDIES ON THE KINETICS AND RADIATION SENSITIVITY OF DENDRITIC MACROPHAGES. Hunter, R. L.; Wissler, R. W.; Fitch, F. W. (Chicago Univ., Ill. Dept. of Pathology. Argonne Cancer Research Hospital, Chicago, Ill. National Institutes of Health, Bethesda, Md.). June 26, 1968. Contract AT(11-1)-69. 14p. (CONF-680634-1). Dep. CFSTI.

From 2nd Conference on Germinal Centers of Lymphatic Tissue, Padova, Italy.

Rats were injected with antigens consisting of ^{125}I-labeled flagella of Salmonella typhi and titanium dioxide; uptake of these antigens by dendritic macrophages of lymphoid follicles of the spleen was studied. Effects of x radiation on the process and the relationship between the amount of antigen retained by the dendritic macrophages and the peak titer of antibody produced were determined. It was concluded that the dendritic macrophages are part of a dynamic and sensitive system of cells. Several cells interact as a functional unit in the process of removing material from the blood stream and transporting it to the dendritic macrophages. This process can be manipulated and is radiosensitive. In three different experiments there was a correlation between the amount of antigen label retained in the dendritic macrophages and the peak titer of 2-mercaptoethanol resistant antibody produced. This correlation suggests that the amount of antigen transported to and retained by the dendritic macrophages is a main factor in determining the amount of antibody produced. (H.L.W.)

769 (ANL-7360, pp 68-149) TOXICITY OF RADIOELEMENTS. (Argonne National Lab., Ill.).

The experimental method of neutron activation analysis of biological and environmental samples was evaluated. Ion-exchange chromatographic techniques were used for separation of radioactive products from neutron activation. Gamma-ray spectrometry in conjunction with computer resolution of spectra was used for analysis of complex mixtures of radionuclides. Yields of the nuclides, ^{24}Na, ^{60}Co, ^{233}Pa, ^{64}Cu, ^{69}Zn, ^{115}Cd, ^{51}Cr, and ^{99}Mo are tabulated. Gametes of several species of sea urchins were x-irradiated, and effects of sodium azide and colcemide on pre- and post-fertilization recovery from cleavage delay were studied. Data are presented for ^{210}Pb and ^{226}Ra excretion by radium dial painters. The relations between ^{210}Pb, ^{210}Po, and ^{226}Ra in marine fish, molluscs, echinoderms, crustaceans, seals, and whales are summarized. It was concluded that contributions of these nuclides to the diet from aquatic fauna are relatively small. A rapid and precise method for the analysis of calcium in blood serum is described. Methods for determining surface : volume ratios of bone by computer analysis of microradiographs are presented. The design of a radon removal system for the NASA lunar sample laboratory is presented. The components, including blower, air drier, air-to-air heat exchanger, charcoal bed, and moisture monitor are discussed in detail. Radon concentrations in coal mine air were measured and results are tabulated for mines in West Virginia, Kentucky, and Tennessee. Studies on excretion and retention of ^{210}Pb in rats were conducted and tables are presented to show ^{210}Pb excretion by the young rat after a single intravenous injection and ^{210}Pb in cellular and plasma fractions of rat blood. Alkaline earth metabolism in animals and man is discussed; an explanation for power function retention in adult bone, based on radial diffusion from canaliculi, is presented. Studies on calcium pools and the power function included determination of ^{45}Ca metabolism in bones of beagles and design of a model based on observed retention function of alkaline earths. The use of polaroid film for autoradiography of bones containing ^{226}Ra is discussed. Rickets was produced in rats by deficient diets and changes in bone structure were studied using high resolution autoradiography with ^{3}H-thymidine. Runt disease was produced in neonatal mice by injection of spleen cells from a mature donor and skeletal changes were studied. Thorotrast was injected intravenously into rats and deposition in tissues was traced by autoradiography. Particular emphasis was placed on skeletal anomalies. Studies on the content of stable lead and ^{210}Pb in rainwater showed that there was a good mixing of Pb and ^{210}Pb in the atmosphere before they were returned to the earth in rainfall. Environmental contamination of plants with lead from air, water, and soil was determined and it was concluded that a substantial fraction of the lead in man's food may be obtained from the soil. (H.L.W.)

770 (BNWL-804) NEPTUNIUM METABOLISM. A Bibliography and Summary of Pertinent Data. McConnon, Dan (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1968. Contract AT(45-1)-1830. 8p. Dep. CFSTI.

Information from the literature on metabolism of ^{237}Np and ^{239}Np is summarized. A list of 26 references is included. (H.L.W.)

771 (CEA-R-3421) WAYS OF UPTAKE FOR A FRESHWATER BIVALVE OF RADIOSTRONTIUM AND ITS LOSS (ANODONTA CYGNEA (L)). Cancio, David; Foulquier, Luc; Grauby, Andre (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar. 1968. 47p. (In French). Dep.

The authors summarize general ideas concerning the ecological characteristics of Anodonta cygnea, commonly found in the hydrological system of the Rhone river. Experimental conditions to follow the evolution of the animal's activity level are described. In general, the amount of strontium-85 retained by these organisms is low as compared to the existing activity in the aquaria (2 to 9%); after 35 days a state of equilibrium is reached. The shell retains more than 50% of the animal activity by adsorption mechanisms. The gills show a fixation capacity higher than the rest of the other organs. The concentration factor is about 9 for the entire animal, 4 for the shell and 78 for whole of the soft tissues. The presence or absence of sediment has no influence on the accumulation process and the fixation capacity of the organisms. The absence of light decreases the concentration factor, this is due probably to a reduction of the contamination through micro-organisms. The decontamination does not follow a simple law; a rapid loss in the activity T 1/2 ≃ 8 days) is followed by a slower elimination (T 1/2 ≃ 72 days). Undependent on the type of experiment, the distribution of the activity in the organisms was similar, i.e., the shell represents almost 45% of the animal activity, the soft tissues 40% and the inner liquids 15%. (auth)

772 (COO-1243-13) A STUDY OF THE PHYSIOLOGICAL FUNCTION AND HISTOLOGICAL CHANGES IN THYROIDS IRRADIATED WITH RADIOACTIVE IODINE. Summary Report, August 1, 1951-June 1, 1968. Dobyns, Brown M. (Case Western Reserve Univ., Cleveland, Ohio. School of Medicine). June 28, 1968. Contract AT(30-1)-1243. 25p. Dep. CFSTI.

A technique of starch column chromatography for the separation of iodinated amino acids was developed. Because of technical difficulties of this method comparable separations were attempted using diatomaceous earth columns. Thyroxine and triiodothyronine were separated more completely by this method than by the starch column method. Synthesis of the thyroid hormone was studied by incubating thyroid slices in a nutrient solution containing ^{14}C labeled tyrosine. Iodide labeled with ^{131}I was used in other experiments on synthesis of the thyroid hormone. Cellular changes in human thyroids treated with ^{131}I were studied. Changes in cellular structure and function were studied in rats injected with varying doses of ^{131}I. Following irradiation, a persistent increase in cell height of the thyroid epithelium occurred. Bizarre nuclear forms became apparent after administration of thiouracil. Observations were made on hospital patients given ^{131}I therapy for hyperthyroidism. Iodine-131 uptake and hormone production were measured to determine functioning of the irradiated gland. Biochemical data were related to the effects of the total dose of radiation and to the

clinical course of the disease. Studies were conducted on a large number of ^{131}I treated patients by the United States Public Health Service. Data were prepared on sequential blood levels of ^{131}I, disappearance rates over the thyroid, sequential urinary excretion of radioiodine, and the appearance and disappearance of iodinated compounds in the circulation as related to clinical effects. Disappearance of ^{131}I from the thyroid following a therapeutic dose could be described by three types of curves: a very rapid decline; a high uptake followed by a very slow gradual decline of ^{131}I from the thyroid; and a well sustained ^{131}I level in the thyroid for seven to twelve days followed by a break in the curve and a sharp decline. Studies on patients treated with ^{131}I for thyrotoxicosis showed that the presence of ^{131}I in the form of mono- and diiodotyrosine represented products of disintegration of thyroid tissue. Paper electrophoresis was used to study the iodinated proteins and polypeptides in the circulation following ^{131}I therapy. The fate of triiodothyronine was observed in hyperthyroid patients by quantitative serial chromatograms on samples of serum and urine. For determining DNA content of individual thyroid cells, rats were given various doses of ^{131}I and one-half of the group was given thiouracil. Those receiving ^{131}I alone showed slight variation in DNA content and nuclear size. The administration of thiouracil caused an increased variation in nuclear size and in DNA content. DNA content and nuclear volume of large bizarre nuclei in human thyroid tissue were determined. Mitotic activity in irradiated thyroids was studied using tritium-labeled thymidine. Studies were made on the development of neoplasms in irradiated rat and human thyroids. Observations on chromosomes in the leukocytes of a thyroid carcinoma patient treated with large doses of ^{131}I revealed numerous breaks, deletions, and fragmentations. Studies on peroxidase activity in the thyroid and other tissues were conducted. Two hundred patients previously given x-ray therapy for tuberculous cervical lymphadenitis of the neck were examined for thyroid tumors. Twelve of these were found to have benign or malignant thyroid tumors. (H.L.W.)

773 (JPRS-45305) CERTAIN BIOLOGICAL AND BIOCHEMICAL ASPECTS OF THE USE OF IONIZING RADIATION IN IMMUNIZATION AGAINST PARASITIC DISEASES. Jovanovic, Milovan. Translated from pp 113-21 of Spomenica u Cast Novoizabranih Clanova Srpske Akademije Nauka i Umetnosti, Belgrade, 1967. 11p. CFSTI.

Larvae of the nematode, Dictyocaulus filaria, were γ- and x-irradiated, and lambs were vaccinated with the irradiated larvae. It was established that 81.8% of the vaccinated animals were resistant to the introduction of high doses of infective larvae on the 15th day after the injection of the second dose of vaccine. In other tests animals already infected with larvae were vaccinated; vaccination was followed by a marked reduction in the number of infected animals. Biological effects of radiation on helminth larvae are discussed. It is pointed out that the effects of radiation are influenced by many factors, such as type of radiation, total dosage, composition of the medium, temperature, stage of development of the organism, and physiological state of the organism. Experiments on the effects of dose of γ radiation on the first and third larval stages of D. filaria showed that larvae of the first stage were more sensitive than those of the third stage. Studies were conducted on the effects of x radiation on metabolism of nucleic acids in infective larvae. It was shown that radiation significantly reduced the incorporation of tritium-labeled uridine into nucleic acids. (H.L.W.)

774 (NYO-3597-7) AN EXPERIMENTAL STUDY OF LEAF DEVELOPMENT IN CERTAIN OF THE VASCULAR PLANTS. Kuehnert, Charles Carroll (Syracuse Univ., N. Y.). May 1968. Contract AT(30-1)-3597. 37p. Dep. CFSTI.

Studies on the development of the fern, Osmunda cinnamonea, in sterile culture demonstrated that leaf primordia were not irreversibly determined as leaves. Results supported the hypothesis that a morphogenetic factor is formed in certain of the older primordia that is transmitted to younger primordia to influence the latter to be expressed as leaves rather than shoots. Other studies were conducted on expression potential of undetermined primordia separated by a barrier membrane from undetermined or determined primordia. Thermal inactivation studies were conducted on the stability of the leafness morphogen. Results of initial studies on photomorphogenetic responses of leaf primordia are reported. Effects of various wavelengths of light on chlorophyll synthesis in primordia indicated that phytochrome was the active photoreceptor. Primordia treated with red or blue irradiation synthesized considerably less chlorophyll than those treated with white light. Neither far-red nor yellow irradiation stimulated chlorophyll synthesis above that of dark controls. (H.L.W.)

775 (ORO-3488-8) THE BIOGEOCHEMICAL CYCLE OF ^{134}Cs IN TWO NATIVE STANDS OF ANDROPOGON SCOPARIUS MICHX. Dodd, J. D. (Texas Agricultural Experiment Station, College Station). Aug. 16, 1968. Contract AT(40-1)-3488. 54p. Dep. CFSTI.

Andropogon scoparius crowns are a collection of individual plants. Concentrations of ^{134}Cs occurred in the roots and inflorescence. Transport of cesium from foliage to roots occurred with fall dormancy. Spring growth initiated export of cesium to the expanding leaf blades. Litter deposition throughfall, and root exudation were transfer mechanisms. Cesium was apparently fixed in the clay soil. In the less fertile sandy loam soil, plants continued to absorb ^{134}Cs, establishing a cycle. Cesium activity occurred in the soil to depths of 150 cm and radially to 180 cm. Movement was due to leaching of clay micelles and attached ^{134}Cs ions along cracks. High activity injections of ^{42}K into A. scoparius tillers resulted in no visual damage, but transport blockage to the roots was indicated at 3400 mCi. Leaf-sheaths were the concentrating organs in the vegetative tillers, even when ^{42}K was soil applied. Similar distribution patterns occurred for ^{42}K and ^{134}Cs in flowering tillers. Culm activity declined during dark periods and increased during light periods. Distribution of activity became more uniform in the tillers with time. Movement of $^{3}H_2O$ in pricklypear was dependent on time, plant phenology, and diurnal conditions. No moisture or activity was encountered in vapor samples during daylight hours. Developing pads showed high concentrations of activity. Center stringers imported activity earlier than laterals. (auth)

776 (UCLA-34-P-118-4) [RADIATION RESEARCH]. Annual Report, July 15, 1967-July 1, 1968. (California Univ., Los Angeles. Dept. of Radiology). Contract AT(11-1)-34. 32p. Dep. CFSTI.

The nature, degree, and kinetics of unscheduled thymidine incorporation previously shown to occur in 90% of irradiated lymphocytes were studied. The incorporation was severely depressed in the presence of acriflavine and by low temperature but was unaffected by hydroxyurea or caffeine. Over a dose range of 25 to 400 ergs/mm^2 the uptake of thymidine was increased only by a factor of 1.6 although the survival of lymphocytes, measured five days after irradiation, decreased by almost two orders of magnitude. After exposure to 25 ergs/mm^2 over 70% of the cells survived for five days in culture; moreover, cells that were stimulated by this dose to incorporate thymidine transformed and divided after exposure to PHA. The final uptake of thymidine was significantly greater when a total dose of 75 ergs/mm^2 was fractionated into three 25 ergs/mm^2 doses given at six hr intervals than when given as a single dose. The degree of thymidine incorporation and the fraction of leukemic cells labeled was not significantly different from that in normal lymphocytes. (auth)

777 (UR-49-935) UNIVERSITY OF ROCHESTER, ATOMIC ENERGY PROJECT: BRIEF DESCRIPTION OF RESEARCH PAPERS ACCEPTED FOR PUBLICATION DURING 1967. Annual Report. Rothstein, Aser; Neuman, William F. (Rochester Univ., N. Y. Atomic Energy Project). May 1, 1968. Contract W-7401-eng-49. 118p. Dep. CFSTI.

Brief descriptions are presented of research papers accepted for publication at the University of Rochester during 1967. The titles are grouped into the following categories; general effects of radiation, toxicity of radioelements, molecular and cellular level studies, radiological and health physics and instrumentation, chemical toxicity, and cancer research. (E.R.B.)

778 INFLUENCE OF SPERMIDINE ON THE REACTIONS OF RNA NUCLEOTIDYLTRANSFERASE. Petersen, Eiko E.; Kroeger, Hans; Hagen, Ulrich (Univ., Freiburg i. B. Kernforschungszentrum, Karlsruhe, Ger.). Biochim. Biophys. Acta, 161: 325-30(July 23, 1968).

RNA synthesis, catalyzed by RNA nucleotidyltransferase (Escherichia coli B) and directed by native, double-stranded DNA, is significantly increased by spermidine. By use of doubly labeled ATP ([8-^{14}C]- and [γ-^{32}P]-) and by zone centrifugation, in the presence of spermidine, more RNA chains are initiated. DNA irradiated with x-rays or ultraviolet light does not change the effect of spermidine on RNA synthesis. However, heat-denatured DNA prevents this influence. In the case of poly A synthesis, no interference by spermidine can be observed. The stimulation by spermidine is considerably lower when a more purified enzyme fraction was used. (auth)

779 THE EFFECT OF NANDROLONE-DECANOATE ON IRON METABOLISM OF ORGANISMS AFTER IRRADIATION. Adam, Geza; Miltenyi, Laszlo; Dezsi, Zoltan; Jona, Gabor (Univ. of Debrecen, Hungary). Strahlentherapie, 136: No. 1, 113-15(July 1968). (In German).

The effect of a synthetic steroid nandrolone-decanoate, upon iron metabolism was investigated in rats. A significant iron increase was observed, especially when the steroid was given prior

to γ irradiation. Furthermore, the cumulation ability of the liver after irradiation was demonstrated once again. (auth)

780 BIOCHEMICAL EFFECTS OF IONISING RADIATIONS. Sreenivasan, A. (Bhabha Atomic Research Centre, Trombay, India). pp 217-54 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6–9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The effects of radiation on biological systems from a biochemical point of view are discussed in detail. Metabolic or structural anomalies that may result in impairment of hereditary mechanisms or in the death of an organism are included; the roles cellular organization, nuclear function (DNA and RNA), and metabolic alterations play in these events are evaluated. (B.S.L.)

781 ALTERATIONS OF THE VESSEL WALL IN THE CAPILLARY BED AFTER IRRADIATION WITH FAST ELECTRONS: EXPERIMENTAL STUDY OF THE PROTECTIVE SUBSTANCE TRIHYDROXYETHYLRUTOSIDE (THR) BY MEANS OF THE RABBIT'S EAR CHAMBER. Klemm, K. J. (Univ., Munich). pp 1-7 of 4th European Conference on Microcirculation, Cambridge, 1966. Harders, H. (ed.). Basel, S. Karger.

Rabbit ear chambers were examined microscopically after receiving 1000, 2000, or 3000 R doses of 6 MeV electrons. During and immediately after the irradiation pronounced hyperaemia was observed and the terminal vessels were dilated. An increased influx of leucocytes was seen. These changes occurred with all three doses, the threshold being below 1000 R. The phenomena were evident at four hr then decreased according to the dose. Following doses of 1000 R and up, edema of the endothelial cells of the capillary wall began. Functionally, narrowing of the capillaries slowed blood flow. After 1000 R some vessels were irreversibly damaged and showed thrombosis, microhematomas, and increased penetration of cells into the interstitial space. After irradiation with 2000 and 3000 R there were foci of necrosis, decomposition of the vessel wall, rupture with hematoma, and interstitial tissue fluid accumulation. Whereas after 1000 R the regions of vascular defects showed sprouting of new vessels during the following four or five days, local regeneration was absent after 2000 R or 3000 R. Thrombi penetrated the interstitial space, destroying the basal membrane, with an increase in the number of macrophages and histiocytes. Chambers irradiated with more than 1000 R became necrotic and unobservable after four to five days. These alterations were decreased after prior administration of the flavonoid, trihydroxyethylrutoside (THR). After irradiation the initial alterations were similar in control and THR-treated animals, but the subsequent reaction of the capillary wall cells and basal membrane was decreased after 1000 R. The protective effect seemed to depend on the blood supply. There was no destruction of endothelial cells and the basal membrane. Edema was less than in untreated animals, and after 48 hr the chamber looked normal again. After 2000 to 3000 R hemolysis, thrombosis, and necrosis were reduced. THR did not completely prevent necrosis after 3000 R but definitely delayed it. (BBB)

782 FISSION PRODUCTS: SITES FOR THE ELIMINATION OF ^{137}Cs IN THE NEPHRONS OF DOGS. Sastry, B. V. Rama; Spalding, Charles T. (Vanderbilt Univ., Nashville). Toxicol. Appl. Pharmacol., 12: 141-55(Mar. 1968).

The mechanisms of the renal excretion of ^{137}Cs were studied in the anesthetized dog using classical clearance techniques, stop-flow studies, and pharmacologic agents known to affect potassium transport in the nephron. The clearance of ^{137}Cs was less than that of creatinine. The bulk of the filtered ^{137}Cs was reabsorbed in the proximal tubule, and it was secreted into the lumen of the distal tubule. There was no linear relation between the plasma concentration of ^{137}Cs and the clearance ratio of ^{137}Cs and creatinine. Sodium chloride loading and hypertonic mannitol increased the excretion of ^{137}Cs. Complete inhibition of renal carbonic anhydrase by acetazolamide increased the excretion of ^{137}Cs. About 55% of this increase in ^{137}Cs excretion was blocked by meralluride, indicating that acetazolamide increased a part of ^{137}Cs excretion by increasing its secretion. There was a distinct peak in the stop-flow pattern for the secretion of ^{137}Cs in the distal segment of the nephron under mannitol diuresis. The ratio of ^{137}Cs clearance to glomerular filtration rate was about 2 at the peak, indicating net secretion in the distal segment. The clearance ratio of ^{137}Cs and creatinine was less than unity in the proximal segment, suggesting net reabsorption. (auth)

783 EFFECT OF EXPERIMENTAL X IRRADIATION ON INTRAOCULAR TENSION AND PERMEABILITY OF OCULAR VESSELS. Mikheeva, E. G. Oftal'mol. Zh., 19: 195-200(1964). (In Russian).

The role of nervous system in the changes of intraocular tension taking place after x irradiation of rabbits was studied. The data obtained were compared with those on the changes of permeability of hemato-ophthalmic barrier under the action of x rays. By 3.5 hr after x irradiation of eyes with the doses of 300 to 1000 R intraocular tension was increased to various degrees in 23 rabbits out of 40 tested, the permeability also increasing almost in all cases. One intravenous administration of pentaminum in the dosage of 5 mg/Kg did not change intraocular tension and permeability of vessels. The administration of pentaminum 5 min before irradiation of the eye produced a sharp increase of intraocular tension and permeability 3 to 3.5 hr after irradiation. One intravenous administration of aminazinum in a dose of 5 mg/Kg decreased intraocular tension to some degree in three out of five rabbits, permeability decreasing in all five rabbits. Intravenous administration of aminazinum before and after irradiation of the eye with the doses of 700 or 500 R caused a decrease of the x-ray effect on intraocular tension as well as on the permeability of ocular vessels. The frequent correspondence of the change in intraocular tension and permeability of hemato-ophthalmic barrier after x irradiation and after the combination of the x-ray effect with pentaminum and aminazinum was explained by the fact that neuro-reflex mechanisms controlling intraocular tension and permeability of eye vessels are the same. (BBB)

784 CELL AND MITOSIS PATTERN OF NORMAL AND X-IRRADIATED REGULATING EMBRYONIC RUDIMENTS IN GRYLLUS DOMESTICUS. Schwalm, Fritz E. (Univ., Marburg, Ger.). Z. Morphol. Okol. Tiere, 55: 915-1023(1965). (In German).

Preparation methods were developed which made it possible to follow nuclear and cellular behavior within the embryonic rudiments accurately. The development of the embryonic rudiments of the cricket, Gryllus domesticus, after x irradiation was investigated in order to obtain data on the pattern of regulation processes. The special principles of the morphological egg structure and the configuration of transformations are emphasized. The radiation resistance of embryonic rudimentary cells was determined 47 to 52 hrs after egg laying. The regulation phenomenon and its absence after whole egg irradiation with doses of 500 and 1000 R were measured. Partial egg irradiation was also investigated in order to determine the regulating mechanisms of the nuclear material from unirradiated part of the egg. The results are reported and discussed in detail. (J.S.R.)

785 INFLUENCE OF X-IRRADIATION ON THE DYNAMICS OF THE PREVENTIVE PROPERTIES OF THE BLOOD SERUM OF RABBITS IMMUNIZED AGAINST TYPHOID FEVER. Pogosyan, M. O. (Ministry of Health, Erevan). Radiobiologiya, 8: 569-72(1968). (In Russian).

The dynamics of the preventive properties of blood serum were studied under conditions of irradiation and immunization. The rabbits were subjected to three vaccinations against typhoid fever at various periods after irradiation at a dose of 800 R. The investigations revealed that preliminary x irradiation of rabbits substantially inhibits the stimulating effect of the subsequent immunization upon the preventive properties of the serum. (JPRS)

786 POSITIVE REACTIONS OF THE PLASMA WITH A LYSATE OF AUTOERYTHROCYTES AS A FUNCTION OF THE IRRADIATION DOSE AND ADMINISTRATION OF S,β-AMINOETHYLISOTHIURONIUM. Lavrenchik, E. I. (Inst. of Labor Hygiene and Occupational Diseases, Moscow). Radiobiologiya, 8: 565-8(1968). (In Russian).

The number of positive reactions of the plasma with a lysate of autoerythrocytes of mice of the CBA line is directly dependent upon the irradiation dose (in the dose range from 300 to 850 R). When AET was administered to mice irradiated at doses of 700 and 850 R, the protective effect upon the immunocompetent cells was only half that upon the bone marrow cells, while the dose reduction factor with respect to autoantibodies was 1.5. In crossed experiments with an erythrocyte lysate and plasma of mice irradiated at a dose of 700 R and nonirradiated mice, it was shown that the plasma of the irradiated animals also reacts with the erythrocyte lysate of nonirradiated animals, while the plasma of nonirradiated animals does not react with erythrocytes of irradiated animals. (JPRS)

787 STUDY OF THE DYNAMICS OF THE ACCUMULATION OF RADIOISOTOPES BY MARINE ORGANISMS BY CYBERNETIC METHODS. Bachurin, A. A. (Inst. of Biology of Southern Seas, Sevastopol). Radiobiologiya, 8: 600-2(1968). (In Russian).

The application of methods of cybernetics for the study of the dynamics of the accumulation of radioisotopes by marine organisms was demonstrated in the work. The following characteristics of the investigated systems were determined: the transmitting function, the differential equation of the transitional process of accumulation, when in general the concentration (activity) of the radioisotope in water is variable with all other factors of the medium constant; the analytical expression for the transi-

tional characteristic for step-wise perturbation of the concentration of the radioisotope in the medium, representing the sum of two exponential functions. (JPRS)

788 ORGAN SPECIFIC ^{137}Cs UPTAKE BY RATS. Bretfeld, G.; Muth, H.; Oberhausen, E. (Univ. des Saarlandes, Hamburg). Biophysik, 4: 343-55(1968). (In German).

The distribution of ^{137}Cs after intraperitoneal injection and the content of K were determined in the blood and 22 organs of five rats. The calculation of the 95% confidence limits shows statistically clear deviations in the enrichment of ^{137}Cs in comparison with K in the various organs and in anatomically different skeletal muscles. The investigation of other cells such as the erythrocytes is recommended for the analysis of the origin of this phenomenon. In this way it could be clarified whether differing behavior of Cs and K in the transport through cell membranes plays a role in the varying enrichments in the organs and tissues. (tr-auth)

789 NUMERICAL SOLUTIONS OF RADIONUCLIDE TRANSPORT EQUATIONS AND ROLE OF PLANTS IN ^{85}Sr TRANSPORT. Armstrong, Neal Earl. Austin, Tex., Univ. of Texas, 1968. 153p.

Thesis.

The role of plants in ^{85}Sr transport in aquaria and a model river was examined, and a numerical solution to the dispersion equation with convection was derived and extended to include plant sorption. Using the macrophtye, Vallisneria americans Michanx, it was found that almost instantaneous equilibrium was reached with ^{85}Sr in solution through adsorption followed by a slower and more complete uptake by adsorption. A characteristic pattern of uptake and release was observed after instantaneous releases into both aquaria and at stations downstream from the point of release in a model river. Under continuous release, uptake tended toward an equilibrium level, which was a function of the amount of attached algae present. It was concluded for conditions used in this study that plants played a negligible role in ^{85}Sr transport. The uptake of ^{85}Sr by plants after instantaneous release could be modeled using a sorption-desorption equation. Instantaneous dye and ^{85}Sr releases were made in the model river to determine the dispersion coefficient and tracer cloud velocity with the two station method using only a selected portion of the concentration-time curves. The best cut-off point for this portion was the point where one-tenth the peak value was observed. Solutions of the numerical model using constants calculated in this manner gave better fit to the observed data than methods previously used. Constant release data could also be predicted with this model using revised initial conditions. A numerical solution to the equations relating dispersion to plant uptake was also derived but not extensively tested. It was concluded that numerical solutions may hold more promise in this area than analytical solutions because of their versatility and ease of computation. (Diss. Abstr.)

790 RADIOSENSITIVITY OF SOLUTIONS OF DOUBLE-STRANDED AND SINGLE-STRANDED DEOXYRIBONUCLEIC ACIDS. Struchkov, V. A.; Strazhevskaya, N. B. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya, 8: 609-10(1968). (In Russian).

The effects of irradiation upon native and single-stranded DNA, which was produced after thermal denaturation of its solutions at 90°C for 10 min and rapid cooling at 0°C, were investigated in model experiments. The magnitude of the radiation effect was judged according to the change in the intrinsic viscosity of DNA samples after thermal decomposition of the strands, which reveals latent single breaks in the polynucleotide chain of DNA. In order for the temperature conditions of the experiments to be the same before and after irradiation, all the DNA samples were additionally heated for 5 min at 90°C before measuring the intrinsic viscosity, and then rapidly cooled at 0°. It was established that single-stranded and double-stranded DNA have the same radiosensitivity. (JPRS)

791 ADRENOCORTICAL ACTIVITY IN PATIENTS WITH ACROMEGALY BEFORE AND AFTER X-RAY THERAPY OF THE PITUITARY GLAND. Materlik, Hubert; Zych, Franciszek (1st Clinic of Internal Diseases, Katowice, Poland). Endokrynol. Pol., 17: 329-34(May-June 1966). (In Polish).

Clinical observations were conducted over 2 to 12 yr on 48 acromegaly patients (32 females, 16 males), aged 14 to 65 yr, who received 1500 to 8000 R total doses of x irradiation focussed on the pituitary gland. The levels of 17-ketosteroids (17-KS) and 17-hydroxycorticosteroids (17-OHCS) in urine were determined as a measure of the effect of irradiation. The excretion of 17-KS (from 1.0 to 68.5 mg/100 ml) prior to irradiation was normal in 36%, elevated in 21%, and decreased in 43% of the cases. The same patients revealed similar results in 17-OHCS excretion levels, except for 41% of cases which were rated as normal. The post-irradiation data for the patients indicated increased quantities of excreted 17-KS metabolites. The majority (81%) of patients showed within several weeks to 2 yr after irradiation a progressive, distinct increase (from 0.8 to 14.5 mg/100 ml) of 17-KS excretion in the urine, and to a lesser degree of 17-OHCS excretion. Tabulated data show the exact percentages. (BBB) (TSS)

792 EXPERIMENTAL STUDIES FOR THE EFFECT OF ^{95}Zr-^{95}Nb ON ALBINO RATS. II. DISTRIBUTION OF ^{95}Zr-^{95}Nb AMONG ORGANS AND EXCRETION OF THEM WHICH WERE ORALLY ADMINISTERED TO RATS. Morishige, Toshiko (Kyushu Univ., Japan). Idengaku Zasshi, 23: 247-51(June 1968). (In Japanese).

As previously reported, $^{95}Zr-^{95}Nb$ were detected in fallout and also in vegetation in the Fukuoka Prefecture even at times other than occasions of nuclear explosion. It is suggested that an intake of a considerable dose from these radioactive agents may occur in common daily dietary food. A previous report described the distribution and excretion of these radioactive agents in subcutaneously injected rats. Oral administration to rats using intubation technique was carried out in this study and the distribution and excretion of these radioactive agents were followed with a G. M.-tube counter. Radioactivities of every observed organ other than the stomach revealed the maximum value at the 24th hour after the administration, rapidly reduced up to the 7th day and then reduced very slowly. A significant deposition of $^{95}Zr-^{95}Nb$ in tibia as distinguished from other organs was not observed in early stages after the oral administration although it differed from the former subcutaneous injection. But on day 63 after administration, the deposition of $^{95}Zr-^{95}Nb$ in the tibia was second only to spleen. Excretion of $^{95}Zr-^{95}Nb$ was 66.22% of the total by the 7th day after administration and was found in feces more than in urine. From the fact mentioned above, it is considered that $^{95}Zr-^{95}Nb$ given orally to rats may be poorly absorbed in the alimentary tract. (NSA of Japan) (TSS)

793 ENDOCRINE FUNCTION OF THE OVARIAN INTERSTITIAL GLAND OF RABBITS. Keyes, P. L.; Nalbandov, A. V. (Univ. of Illinois, Urbana). Endocrinology, 82: 799-804(Apr. 1968).

The effects of 1,500 R x radiation on the ability of interstitial tissue of the rabbit ovary to maintain pregnancy and to secrete progestin was investigated. X irradiated ovaries which contained only interstitial tissue failed to maintain pregnancy following the removal of contralateral normal ovaries containing corpora lutea. Neither a small dose of estradiol (3 μg/day) nor large doses of gonadotrophin (chorionic gonadotrophin, whole pituitary powder, or NIH-LH) were able to prevent interruption of pregnancies in doses with an x-irradiated ovary. Control, unirradiated does, pregnant in one uterine horn, maintained pregnancies to term in the majority of cases following sham operation or removal of a contralateral ovary. By chemical determination, neither ovarian venous blood nor the x-irradiated ovary with only interstitial tissue contained measurable quantities of progesterone, but 20α-hydroxy-4-pregnen-3-one (20α-OH) was found in copious amounts. It was concluded that interstitial cells are stimulated directly by gonadotrophin to synthesize and to secrete 20α-OH. The failure of interstitial tissue to maintain pregnancy is considered to be primarily attributable to the inability of this tissue to secrete significant quantities of progesterone. (auth)

794 ON THE OCCURRENCE AND SIGNIFICANCE OF RADIOCESIUM IN BULL SEMEN. Ekman, L.; Greitz, U.; Gustafsson, B.; Thorell, C. B. (Royal Veterinary Coll., Stockholm). Acta Vet. Scand., 8: 98-110(1967).

The distribution and concentration of radiocesium in bull semen were determined after oral administration. Two bulls were given 2.5 mCi ^{134}Cs in water solution with a stomach tube, semen was collected, and the concentration of ^{134}Cs in seminal plasma and spermatozoa was measured. From one week to the end of the experimental period (88 and 107 days, respectively) the ratio between ^{134}Cs in spermatozoa and seminal plasma was fairly constant. The level in spermatozoa was only about 35% of that in seminal plasma, which is remarkable since the intracellular concentration of Cs usually is higher than the extracellular. The concentration of ^{134}Cs in the blood cells of the two bulls was also considerably higher than that in the blood plasma. Concentration of ^{134}Cs in bull semen could be described by a 4-term exponential expression, and it was calculated that the concentration after an infinite daily intake would be 2.6×10^{-3}% of the daily dose per ml semen. If deposition of fallout in the pasture where a bull is grazing is 3.4×10^{15} fission/m^2 (corresponding to a dose rate of about 100 R/hr), the dose to spermatozoa in testis and epididymis from ^{137}Cs will be about 60 mrad, assuming a maximum residence time of 70 days of the spermatozoa in testis and epididymis. The dose to the spermatozoa diluted 10 times (10 to 20 is a common dilution rate), and then stored in a semen bank for one year, would be about 20 mrad. In all, the total dose would thus not exceed 0.1

rad. It seems unlikely that the radiation dose to sperm from ^{137}Cs deposited in the body and in the semen would be of any significance in comparison with, e.g., the external dose received from fallout. (BBB)

795 PERCUTANEOUS ABSORPTION FROM CHROMIUM (^{51}Cr) SOLUTIONS OF DIFFERENT pH, 1.4 TO 12.8: AN EXPERIMENTAL STUDY IN THE GUINEA PIG. Wahlberg, J. E. Karolinska Sjukhuset, Stockholm). Dermatologica, 137: 17-25 (1968).

By use of an in vivo technique (disappearance measurements) the percutaneous absorption of ^{51}Cr, in buffered and unbuffered solutions with initial pH values varying from 1.4 to 12.8, was studied in the guinea pig. A higher percutaneous ^{51}Cr absorption rate was observed with the concentrations 0.017 and 0.239M at initial pH of 6.5 or higher (6.5 to 12.8), when compared with initial pH of 5.6 or lower (5.6 to 1.4). This could explain the more intense reactions obtained in patch testing with alkaline Cr solutions, compared with aqueous solutions of potassium bichromate. The pH determinations showed that changes occurred in the composition of the Cr solutions after contact with guinea pig skin. The maximal decrease in pH was 3.15 units after 5 hr in an unbuffered solution with an initial pH of 12.0. On comparing buffered and unbuffered Cr solutions (0.017M), absorption was higher than the buffered solutions with the initial pH values of 1.5 and 12.0. (BBB)

796 ^{137}Cs RETENTION IN MICE OF DIFFERENT AGES. Miller, Charles E.; Finkel, Asher J.; Wright, Nancy B. (Argonne National Lab., Ill.). Proc. Soc. Exp. Biol. Med., 128: 563-6(June 1968).

Analysis of the retention data of mice of various ages demonstrated that after intravenous injection the retention of ^{137}Cs-chloride varied as a function both of the age of the animal at the time of injection and of the time since injection. The effective retention of cesium was lowest in the youngest mice, progressively higher for the older mice and then somewhat lower again for very old mice. Moreover, the retention does not change in a uniform manner that can be described by the sum of a series of exponential terms. If the retention is to be described accurately, it is frequently necessary to use a series of discontinuous exponential terms, each of which describes the retention over a limited time span. (auth)

797 HEPATIC UTILIZATION OF CYSTINE-^{35}S IN NORMAL RATS AND IRRADIATED RATS. Notario, A.; Slaviero, G. E.; Doneda, C.; Santagati, G. (Univ., Pavia, Italy). Arch. Sci. Med., 122: 1-7(July 1966). (In Italian).

Wistar rats, weighing 180 to 2260 g, were irradiated with single whole-body doses of 500 or 1000 R of 120-kV x rays and five hr later injected intraperitoneally with 20 μCi of ^{35}S-cystine. One hr later the animals were sacrificed and the ^{35}S levels were counted in serum and liver tissues and various fractions thereof. Values for cpm/g of dry tissue are tabulated. In general, incorporation of sulfate increased after irradiation. Samples taken five days post-irradiation, showed that incorporation of amino acids into proteins and polypeptides was reduced rather than stimulated as shown in the present one hr postirradiation results. Increased utilization of cystine by liver soon after irradiation may indicate depletion of endogenous sulfhydryl compounds as a consequence of irradiation. (TSS)

798 X-RAY INACTIVATION OF HISTAMINE. Sturde, H. C.; Heitmann, H. J. (Univ. Bochum, Essen). Lancet, 2: 1362(Dec. 23, 1967).

Histamine, 4-(2-aminoethyl)imidazole, has shown effectiveness in radioprotection. Since radioinduced radicals formed from water react with different solutes at widely different rates, it might be expected that irradiation would decrease the activity of histamine dissolved in water, since histamine would apparently also be attacked and changed by the radicals produced. Histamine dissolved in pyrogen-free distilled water at a concentration of 1 μg/ml was x-irradiated and its inactivation was measured on the isolated terminal ileum of a male guinea pig suspended in a bath containing Tyrode's solution. The results showed that histamine activity decreased in inverse ratio to the radiation dose. Further investigations with frozen and dried histamine demonstrated no changes in activity after x irradiation. The activity of histamine dissolved in water decreased significantly after irradiation with 50 to 8000 R. The radioinduced effect followed the very small dose of 50 to 100 R and supported the concept that the radioinduced radicals formed from water were responsible for the inactivation of histamine. (BBB)

799 DNA METABOLISM IN TETRAHYMENA PYRIFORMIS. Brunk, Clifford Franklin. Stanford, Calif., Stanford Univ., 1968. 167p.

Thesis.

Contrary to the reports in the literature, no satellite density DNA component was found in DNA isolated from Tetrahymena pyriformis strain 6III, HSM, ST, or GL; all the DNA from a given strain had a single buoyant density in CsCl. DNA prepared from isolated contamination-free mitochondria from these strains of Tetrahymena pyriformis had a density identical to that of the nuclear DNA from the respective strain. Attempts to demonstrate that this mitochondrial DNA exists as a covalently bonded twisted circle were unsuccessful. However, the relative utilization of ^{3}H-5-deoxybromouridine and ^{32}P in nuclear and mitochondrial DNA synthesis was shown to be different. This technique is suggested as a general procedure for detecting cytoplasmic DNA when density differences are not evident. The molecular weight of the isolated mitochondrial DNA was $30-40 \times 10^6$ daltons. Ultraviolet and x-ray induced damage in the DNA of Tetrahymena pyriformis appears to be repaired in the dark by an excision-repair system. An improved method for the detection of excision-repair is described, in which all of the DNA is replicated normally after being repaired. Repair synthesis is measured by the amount of post-irradiation label incorporated into the parental DNA strands. Characterization of the repair regions indicates that the average length of these regions is approximately 5000 nucleotides. The substitution of 5-deoxybromouridine for thymidine was found to be only one third as great during repair synthesis as during normal replication. Using this selection characteristic of repair synthesis, it was determined that repair synthesis is most active during the middle of the first generation after irradiation, but may persist for over a generation. (Disser. Abstr.)

800 RADIATION STIMULATED DNA SYNTHESIS IN HUMAN LYMPHOCYTES. Evans, Richard Gordon. Los Angeles, Univ. of California, 1968. 114p.

Thesis.

Lymphocytes obtained from the blood of normal donors were irradiated in suspension with doses of uv radiation in the range 15 to 500 ergs/mm^2 and then resuspended in medium containing tritiated thymidine. A similar study was carried out following doses of ionizing radiation in the range 1 to 16 kiloRads. The survival of the lymphocytes following doses of ultraviolet radiation and the ability of labeled cells to respond to phytohemagglutinin (PHA) was investigated. Preliminary experiments were done using lymphocytes obtained from a patient with chronic lymphocytic leukemia to evaluate the possible usefulness of radiation-stimulated DNA synthesis as a method for labeling lymphocytes for clinical studies. The results were as follows: Ultraviolet and ionizing radiations stimulated the incorporation of tritiated thymidine into the DNA of about 90% of the irradiated cells. The number of grains per cell in this population was unaffected by the presence of 10^{-3} M hydroxyurea in the labeling medium but was reduced eight-fold when 10^{-4} M acriflavine was used. This stimulated DNA synthesis began immediately after the irradiation and was essentially completed 6 hours later. When a total dose of 75 ergs/mm^2 was fractionated into three 25 ergs/mm^2 doses given at 6 hourly intervals, the final uptake of thymidine was significantly greater than following a single dose of 75 ergs/mm^2. Over the dose range 25 to 400 ergs/mm^2, the uptake of thymidine was increased only by a factor of 1.6 although the survival of lymphocytes 5 days after irradiation decreased by almost two orders of magnitude. After exposure to 25 ergs/mm^2 over 70% of the cells survived 5 days in culture, moreover, cells which had been stimulated by this dose to incorporate thymidine would transform and divide after exposure to PHA. The fraction of leukemic cells labeled and also the degree of thymidine uptake was not significantly different than in normal cells. The incorporation of thymidine following the absorption of 1 kiloRad of ionizing radiation was equivalent to about 3 molecules per cell per RAD—a number similar to the calculated number of single strand breaks per RAD in the DNA of human lymphocytes. (TSS) (Disser. Abstr.)

801 EFFECTS OF CALCIUM AND PHOSPHATES ON THE RATIO OF NONABSORBED STRONTIUM TO CALCIUM IN THE GUT. Vojvodic, S.; Kostial, K. (Inst. of Medical Research, Zagreb). Arh. Hig. Rada Toksikol., 19: 32-5(1968).

Female albino rats aged 14 wks that were fed on a standard diet were used in the experiments. After a 12 hr starvation period, the animals received 0.2 μC ^{85}Sr + 0.2 μC ^{47}Ca in 1 ml/H_2O by stomach tube. One group of rats was given 0.5 mmole $CaCl_2$ with the radioactive isotopes, a second 0.5 mmole KH_2PO_4, and a third was used as a control group. After the animals were sacrificed, the $^{85}Sr/^{47}Ca$ ratio in the gastrointestinal tract was determined in units of this ratio in a standard solution of the isotopes corresponding to that administered to the animals. Three hundred min after application of the radioactive isotopes, the ratio in the control animals was 1.63 (versus 1 in the standard solution), which agreed with the well-known fact of higher absorption of Ca from the digestive tract. The ratio was 1.22 for rats that had received

$CaCl_2$ and 2.03 for rats that were given KH_2PO_4. It was concluded from this that phosphates selectively affected Sr absorption because of the lower solubility of Sr phosphate versus Ca phosphate. (JPRS)

802 EFFECTS OF VITAMIN D AND THE PHOSPHATE CONTENT OF THE DIET ON CALCIUM AND STRONTIUM ABSORPTION FROM THE GASTROINTESTINAL TRACT. Kostial, K.; Malikovic, T.; Gruden, N.; Durakovic, A. (Inst. of Medical Research, Zagreb). Arh. Hig. Rada Toksikol., 19: 5-9(1968).

The effects of dietary phosphates and vitamin D on the absorption of Ca and Sr from the gastrointestinal tract were studied in rats. The animals were kept on an experimental diet for six days and during this period received ^{45}Ca and ^{85}Sr with the drinking water. The skeletal retention of these isotopes was determined. Increasing of the content of phosphates in the diet from 0.5 to 1.2% P caused a reduction of the retention of ^{45}Ca and ^{85}Sr after peroral administration of the isotopes. The effect of the phosphates on the Ca and Sr metabolism proved independent of the vitamin D content in the diet, that was varied from 200 to 800 IU per 100 g dry food. (JPRS)

803 EFFECT OF IONIZING RADIATION ON BIOLOGICAL PREPARATIONS. PART 1. EFFECT OF IONIZING RADIATION ON THE VACCINES AGAINST ENTEROXEMIA. Tschentschev, Iwan; Sartmadshiev, Kristjo (Veterinary Inst. for Infectious and Parasitic Diseases, Sofia). Arch. Exp. Veterinaermed., 21: 1531-5(Dec. 1967). (In German).

The effects of 500,000 and 1,500,000 R of γ radiation on vaccines against enterotoxemia types C and D in sheep were investigated. The immunogenic effectiveness of the vaccine decreased with increasing radiation dose. This finding contradicted an earlier report. (JPRS)

804 SERUM CHANGES ACCOMPANYING RESPONSIVENESS AND RESISTANCE TO CANCER. Maisin, J. H.; Guarini, G.; Lovisetto, P.; Serra, A.; Guidetti, E. (Catholic Univ., Louvain). Bull. Acad. Roy. Med. Belg., 7: 289-321(1967). (In French).

A study was made of x factor, a substance lacking in the blood of patients with cancer and that might be involved in immune reactions to cancer cells. In rats with chemically induced hepatomas or sarcomas a deficiency of x factor was also noted. Moreover, rats receiving transplanted tumors lacked this factor in their blood. Radiobiology experiments were conducted to determine the nature of this factor. When rats were injected with an homogenate of hepatoma cells or with sarcoma cells inactivated by exposure in vitro to 10,000 R irradiation, a significant proportion of rats showed disappearance of x factor from the blood. Rats receiving a whole-body dose of 500 R showed a hemolytic type reaction 48 hr after irradiation that persisted up to the 96th hr. The x factor intervening in the fixation of complement was neutralized in these irradiated animals. Clinical observations relating to x factor were made in 122 fetuses, 200 children, and 333 adults. Of the fetuses, only 13.3% showed presence of the factor, and in children the percentage was 0 for age one to six months; it increased gradually with age to 83.2% for the two to 13 yr-old group. It was present in 78% of adults. The x factor was interpreted as belonging to the β-globulin group and to increase with age. It was concluded that it plays a part in natural immunity, since 70 to 96% of cancer patients are lacking x factor. (BBB)

805 RADIOMIMETIC ACTION OF VALINOMYCIN ON THE NUCLEAR STRUCTURE OF RAT THYMOCYTES. Whitfield, J. F.; Perris, A. D. (National Research Council of Canada, Ottawa). Exp. Cell Res., 51: 451-61(Aug.-Sept. 1968). (NRC-9898).

Low concentrations (1.3×10^{-10} to 2.6×10^{-10} M) of the antibiotic valinomycin stimulate cellular respiration and initiate an inorganic phosphate-dependent metabolic reaction which causes the disaggregation of the highly condensed chromatin structures in the nucleus of the unirradiated and irradiated rat thymocyte into a structureless ("pycnotic") nucleoprotein mass. This action of valinomycin can be prevented by 2,4 dinitrophenol or reducing the extracellular inorganic phosphate concentration. The action of valinomycin on the thymocyte very closely resembles that of ionising radiation. Comparison of the known metabolic effects of radiation with those of valinomycin, parathyroid hormone and 2,4 dinitrophenol reveals a characteristic metabolic pattern which can explain the loss of nuclear structure in irradiated thymocytes. (auth)

806 ENZYMES OF GLUCOSE FORMATION AND TURNOVER IN X-IRRADIATED RATS. Deshpande, Lalita D.; Nadkarni, G. B. (Bhabha Atomic Research Center, Bombay). Int. J. Radiat. Biol., 14: 39-47(1968).

Profiles of liver enzymes involved in deamination of amino acids, gluconeogenesis and the hepatic turnover of glucose, were examined for 7 days after whole-body exposure of rats to 600 R of x rays. Aspartate aminotransferase, serine dehydrase and phosphopyruvate carboxykinase activities were enhanced, though maximal effect was observed on different days after x-irradiation, suggesting a chronological order of events. Fructose-1, 6-diphosphatase and glucose-6-phosphotase did not, however, seem to be affected. Glucose-ATP phosphotransferase and glycogen phosphorylase showed immediate reduction and enhancement, respectively, in their activities, though normal levels were restored within a day after irradiation and were maintained throughout the period under investigation. These results, while indicating no evidence for increase in the net synthesis of glucose, suggested that variations in the enzyme activities could be caused by physiological adaptations following a flux of substrates. (auth)

Ecology

Refer also to abstracts 769 and 1728.

807 (ORO-2066-12) GAMMA RADIATION AS A POPULATION CONTROL MECHANISM. Progress Report. Heaslip, Margaret B. (Morehead State Univ., Ky.). June 28, 1968. Contract AT(40-1)-2066. 25p. Dep. CFSTI.

Seedlings of white oak (Quercus alba), black walnut (Juglans nigra), red bud (Cercis canadensis), and white ash (Fraxinus americana) were γ-irradiated at four levels and planted in species plots the day after being irradiated. On the basis of seedling survival and general vigor of surviving seedlings, ash was the most radioresistant and white oak the most sensitive. Survival of all species decreased as the rate of radiation increased; seedlings dormant at the time of irradiation were more radioresistant than physiologically active seedlings. Ash seedlings irradiated while physiologically active not only had a lower survival value, but those that survived also grew more slowly than those irradiated while dormant. Survival data and data on first season mean growth in length are tabulated. Short leaf pine (Pinus echinata), white pine (P. strobus), and Virginia pine (P. virginiana) were planted over nuclear waste disposal pits in eastern Kentucky as a biological check on other methods of determining the efficiency of burial techniques employed. The planting areas were over four burial trenches and two control areas. Length of needles, radial growth, apical dominance, stem elongation, and lethality were used as a measure of radiation effects. Growth of seedlings was recorded as vigorous, poor, and dead. For studies on radiosensitivity of X_1 generation tree seed, seeds from trees of the X_1 generation growing in the UT-AEC pasture in Oak Ridge were collected. Ash and red bud seed were γ-irradiated at 0, 9.7, 14.6, and 19.4 kR. Results in terms of mean per cent germination and survival are tabulated for the X_1 generation and control seeds. Germination of controls was almost twice that of seed from the X_1 generation. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 850, 914, and 933.

808 (TID-24561) GENETIC EFFECTS OF IRRADIATING SWINE. Ninth Annual Report. (Iowa State Univ. of Science and Technology, Ames). [nd]. Contract AT(11-1)-707. 6p. Dep. CFSTI.

One male in each of 30 pairs of full brothers was chosen at random to receive 300 R of x radiation about seven months prior to the breeding season. Each pair of males was mated with five pairs of full sisters forming sets of double first cousin families. Within the families one-half of the progeny were descendents of irradiated spermatogonia. The females used for breeding were sired by control and irradiated males but no females with irradiated maternal grandsires were included. In litters sired by irradiated males, there was an increase in litter size but there was no effect on post-natal growth or body composition. Effects of paternal radiation on birth weight, behavior, and gastric ulcers were also studied. (H.L.W.)

809 POSSIBILITIES OF INFLUENCING RADIOSENSITIVITY AND MUTABILITY IN BARLEY. III. THE COMBINED EFFECT OF X RAYS AND VARIOUS LEVELS OF TEMPERATURE DURING IRRADIATION AND THE INFLUENCE OF HUMIDITY AND THE STAGE OF GERMINATION OF THE CARYOPSES. Krausse, G. W. (Martin-Luther-Univ., Wittenberg, Ger.). Z. Pflantzenzuecht., 60: 19-40(July 1968). (In German).

The influence of different temperature levels during and following irradiation, of redrying the germinated and irradiated grain, and of moisture content and state of germination of barley caryopses on the radiosensitivity and mutability induced by x rays

was studied in spring barley. The radiation effect in the M_1 generation, that was studied in germination dishes and in the field, was characterized by measuring survival rate, length of seedling, roots, plants, fertility, and length of growing period. The rate and the spectrum of chlorophyll mutations and frequency of morphological and physiological viable mutations were determined in the M_2 generation. Temperatures between 3 and 7°C during irradiation intensified its effects. In the range of 12 to 25°C the effect remained roughly similar, while the experiments at higher temperatures allowed no consistent conclusions to be drawn. With irradiation at lower temperatures the mutation rate was increased. The temperature had an influence on the spectrum of chlorophyll mutations. Redrying seeds previously soaked and irradiated increased the effect of x irradiation, while subsequent treatment with high temperatures after x irradiation reduced sensitivity. Caryopses with a moisture content of 15 to 17% were injured least of all by x irradiation. Both higher and lower moisture contents increased sensitivity to radiation. Radiosensitivity and mutability of germinating caryopses are about 16 times higher than those of resting seeds, which lead to a gain in working time and energy in seed irradiation and to more effective means of maintaining the experimental conditions constant. (auth)

810 INFLUENCE OF CHLORAMPHENICOL AND CAFFEINE ON UV RAYS AND MITOMYCIN C STIMULATED TRANSITION OF THE F EPISOME TO THE CHROMOSOME IN ESCHERICHIA COLI K12. Rajchert-Trzpil, M.; Dobrzanski, W. T. (Academy of Medicine, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Biol., 15: 539-43(1967).

The treatment before conjugation of the E. coli K12F^+ donor with uv rays, mitomycin C (MC), and HNO_2 increased the fertility of the donor, measured as the yield of recombinants in $F^+ \times F^-$ crosses; that is, such treatment caused the transition of the F episome into the chromosal state. The influence of chloramphenicol (CM) and caffeine on the uv- and MC-stimulated integration of the episome into the chromosome was studied. The F W1655 donor cells were irradiated before conjugation with a 50 erg/mm² dose of uv, and were subsequently incubated for 45 min at 37°C in broth without or with various concentrations of caffeine. A 45-min period of incubation in broth alone was the optimum one for the manifestation of the effect of uv on the fertility of the donor. Caffeine alone affected the number of cells only insignificantly, whereas uv irradiation of the donor before conjugation resulted in an eight-fold increase in the fertility of the F^+ strain. Caffeine, depending on its concentration, either increased or reduced the effect of uv irradiation. With a 0.01% concentration, a further substantial increase in the fertility of the irradiated F^+ donors was obtained. The yield of the conjugation increased more than 16 times, that is, more than twice as much as in the irradiated control. At a concentration of 0.1%, on the other hand, caffeine reduced the fertility of the irradiated cells, which was explained by its generally inhibitory effect on macromolecule synthesis. Incubation in the presence of CM of uv-irradiated F^+ cells blocked the expression of the stimulating effect of uv rays on the integration of the F episome. The inhibitory effect of CM was not lasting because, following the removal of the antibiotic, the phenomenon of induction of the integration of the episome appeared fully, indicating that the damage caused to the donor by uv or MC and leading to the integration of the episome was relatively stable. (BBB)

811 INFLUENCE OF TEMPERATURE SHOCKS ON THE FREQUENCY OF CHROMOSOME ABERRATIONS INDUCED BY IRRADIATION OF DORMANT SEEDS. Atayan, R. R. (Armenian Scientific Research Inst. of Agriculture, Echmiadzin, USSR). Radiobiologiya, 8: 603-8(1968). (In Russian).

Dormant pea seeds were treated with temperature shocks of 70°C for 30 min directly before and directly after irradiation. The chromosome aberrations during the first mitosis were counted in the rootlets of the seedlings. The dose versus effect and time versus effect curves obtained show that the protective effect of shock is caused by a change in the slope of the time versus effect curves under its influence. It was also shown that under the influence of shock, a decrease in the time of appearance of chromosome aberrations is also observed at rather high doses (up to 30 kR), while this critical dose in the control does not exceed 20 kR. (JPRS)

812 MUTAGENIC EFFECTIVENESS OF γ RAYS IN THE TREATMENT OF UNRIPE PEA SEEDS. Zelenov, A. N. Izv. Timiryazev. Sel'skokhoz. Akad., 6: 162-7(1966). (In Russian).

Air-dried, mature and immature (harvested on the 20th day after fertilization) pea seeds of the Moscow-559 variety were treated with ^{137}Cs γ rays at a dose of 5 kR. In the 1st generation a lower radiosensitivity of immature seeds was observed. Irradiation produced a stimulating effect on the height and productivity of plants, but the quantity of seeds per pod decreased due to partial sterility of pollen. In the 2nd generation, the highest frequency of mutation and broadest mutation spectrum was obtained by irradiation of immature seeds. Also, 1.6 times as many morphological or physiological mutations occurred than chlorophyll ones. As a result of irradiation of mature seeds, an increase in seed weight (weight per 1000 seeds) and in the number of pods per plant was observed along with a decrease in the amount of seeds per pod and per plant. The progeny of immature seeds, irradiated or not, had more seeds per plant, but the seed weight was somewhat lower. The total productivity of the plants was noticeably higher than that of the plants of original variety. (BBB)

813 PHYTOTRON CULTIVATION OF SVALOEF'S BONUS BARLEY AND ITS MUTANT, SVALOEF'S MARI. Dormling, I.; Gustafsson, A.; Jung, H. R.; von Wettstein, D. (Royal Coll. of Forestry, Stockholm). Hereditas, 56: 221-37(1966).

Some differences in the characteristics of an x-ray-induced mutant of barley (Mari variety) and those of its parent variety (Bonus) are described. Bonus barley was marketed as an original Swedish variety and had become widely cultivated, owing to its high yield. Mari barley, or early-a^8, was isolated following x-ray experiments, when it was discovered because of its low stature and pronounced increase in earliness. The gene responsible for the mutation was designated as ea-a^8 and is located in chromosome six. Several other early mutants showed the same locus. In addition to its increased earliness, it was characterized by a remarkable degree of lodging resistance. Under field cultivation, no variety outyielded early-a^8. Mari gave high yields in certain regions of Sweden, Norway, and Finland. Even with low summer temperatures, high precipitation, pronounced cereal lodging, and late harvesting Mari gave high yields in most areas of Sweden. It was however, on an average 8 to 10% lower yielding than Bonus at its place of origin (Svalöf). This decrease in yielding ability was compensated by its increase in earliness (seven to 10 days) and by its extreme lodging resistance. In districts, where the parent variety, or other late varieties, were unsuitable for cultivation, it surpassed them in production of grain. Under controlled phytotron conditions the difference in behavior of the varieties Bonus and Mari was striking. Bonus reacted as a pronounced long-day plant, with its optimum vegetative and generative development under continuous light. At eight hr of light it remained purely vegetative, forming no heading spikes. At 16 hr of light its heading ability was low at high temperatures (25°C). Mari formed heading spikes as well under 16 as under 24 hr of light. The results demonstrated how earliness, low stature, lodging resistance, and high yield could be combined pleiotropically with a conspicuous photo- and thermoperiod insensitivity. (BBB)

814 THE STAGE OF CHROMOSOME DUPLICATION IN THE CELL CYCLE AS REVEALED BY X-RAY BREAKAGE AND ^3H-THYMIDINE LABELING. Monesi, Valerio; Crippa, Marco; Zito-Bignami, Rosanna (Centro Studi Nucleari, Casaccia, Italy). Chromosoma, 21: 369-86(1967).

Experiments with x irradiation and ^3H-thymidine labeling of the chromosomes in the DNA synthesis phase, and subsequent analysis at metaphase of the autoradiographs of the chromosomal damage induced during interphase, are reported. It was shown that in somatic cells from a quasi-diploid Chinese hamster line cultured in vitro the chromosomes changed their response to radiation from single (chromosome type aberrations) to double (chromatid type aberrations) in late G_1. These results indicated that the chromosome divided into two chromatids in G_1, before DNA replication. By extending the observations to the second metaphase after irradiation, it was shown that cells irradiated while in G_2 or late S, when they reached the second postirradiation mitosis, still exhibited, beside chromosome type aberrations, many chromatid exchanges, some of which were labeled. Two hypotheses were suggested to account for this unexpected reappearance of chromatid aberrations at the second postirradiation division. The first hypothesis was that they arose from half-chromatid aberrations. The second hypothesis, based on a new interpretation of the mechanisms of production of chromosome aberrations, was that they arose from gaps or achromatic lesions that underwent, as the cells went through the next cycle, a two-step repair process culminating in the production of aberrations. (BBB)

Health Physics and Safety

Refer also to abstracts 48, 350, 455, 498, 505, 595, 708, 769, 777, 787, 794, 850, 933, and 937.

815 (AD-672097) A STUDY OF METABOLISM OF SELECTED RADIONUCLIDES FED IN VARIOUS PHYSICAL FORMS TO DAIRY COWS. Final Report, February 18, 1966–March 31, 1967. Comar, Cyril L.; Wentworth, Richard A.; Lengemann,

Fredrich W. (New York State Veterinary Coll., Ithaca. Dept. of Physical Biology). Contract N00228-66-C-0268. 45p. (USNRDL-TRC-67-33). CFSTI.

A method for the prediction of the total intake commitments of ^{137}Cs, ^{131}I and ^{90}Sr from milk by average members of a human population following a short term deposition of radioactive fallout on pasture is presented. The method is shown to be independent of level of pasture contamination, solubility of radionuclides in the fallout, and dietary factors such as level of stable calcium in the ration of the cows. The approach is tested with multiple-dose feedings of radionuclides to cows. The effectiveness of removing cows from contaminated feeds and of limiting intake of contaminated milk by humans is presented. (auth) (USGRDR)

816 (ANL-7360) RADIOLOGICAL PHYSICS DIVISION ANNUAL REPORT, JULY 1966-JUNE 1967. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 184p. Dep. CFSTI.

Research progress by the ANL Radiological Physics Division is reported in three sections as follows: Radiological and Health Physics; Toxicity of Radioelements; and Meteorological Studies. A separate abstract was prepared for each section. (R.C.K.)

For abstracts of individual sections see: 455, 769, and 817.

817 (ANL-7360, pp 1-67) RADIOLOGICAL AND HEALTH PHYSICS. (Argonne National Lab., Ill.).

ELECTRIC DISCHARGE TUBES—design and performance of hydrogen-filled, for producing radiation at 1600 to 4000 Å
GASES—electron reactions with, energy transfer processes in
HELIUM—electron reactions with, drift velocity and elastic collision cross section measurements for
ALPHA PARTICLES—reactions (α,n) with materials in earth's crust, production rates of neutrons from
CHARGED PARTICLES—scattering by atoms or molecules, sum rule for Bethe cross section for inelastic
HYDROGEN IONS—oscillator strength distribution of negative
ACETONE, BUTANE, ETHYLENE, AMMONIA—photon reactions with isotope effects on ionization from
HELIUM, NEON, ARGON, KRYPTON, XENON, HYDROGEN, DEUTERIUM, CARBON MONOXIDE, AMMONIA, METHANE, ETHANE, PROPANE—electron reactions with specific primary ionization from
METHANE—electron reactions with deuterated and normal, specific primary ionization from
ALPHA PARTICLES—scattering in gases, use of small-angle theory for analysis of multiple elastic
OXAZOLE,2,5-DIPHENYL-, OXAZOLE,2,2'-p-PHENYLENEBIS [5-PHENYL]-, 1,1'-BINAPHTHYL,4,4'-BIS(1-BUTOXY)-, 1,1'-BINAPHTHYL,4,4'-BIS(1-OCTYLOXY)-, 1,1'-BINAPHTHYL,4,4'-BIS(1-UNDECYLOSY)-, BENZ[E]ACEPHENANTHRYLENE,9,12-DI(N-OCTADECYLOXY)--fluorescence of, effects of solvent on polarization of
FLUORANTHENE, BIPHENYL—properties and structure of, fluorescence studies on
FLUORANTHENE,3-PHENYL-, 3-FLUORANTHENAMINE, BIFLUORANTHENE—properties and structure of, fluorescence studies on
INDOLE—alkyl substituted, preparation and properties of, for use as scintillators; aryl substituted, preparation and properties of, for use as scintillators
1,3,5-HEXATRIENE,1,6-DIPHENYL-, BENZENE,BIS(ISOPROPYLSTYRYL)-, BENZOXAZOLE,2,2'-(2,5-THIOPHENEDIYL) BIS[5-TERT-BUTYL]--fluorescence of, effects of solvent on polarization of
THORIUM OXIDE (ThO_2)—radiation dose to man in relation to epidemiology of leukemia and bronchial carcinoma
DISEASES, NEOPLASTIC—leukemia, radiation dose to man in relation to epidemiology of, thorotrast; carcinomas, radiation dose to man in relation to epidemiology of bronchial, thorotrast
MAN—thorotrast diagnosis of disorders of, survey of, in Chicago
THORIUM OXIDE (ThO_2)—use in radiodiagnosis of disorders in man, survey of, in Chicago (B.G.D.)

818 (HASL-197(App.)) APPENDIX TO FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, MARCH 1, 1967-JUNE 1, 1968. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1, 1968. 254p. Dep. CFSTI.

Results are presented of the Health and Safety Laboratory fallout sampling program. Included in the report are: ^{89}Sr and ^{90}Sr in monthly deposition at world landsites, radiostrontium deposition at Atlantic Ocean weather stations, radioisotopes in monthly surface are samples, and radiostrontium in milk and tap water. All of the data are presented in tabular form. Conversion factor and radioisotope tables are also included. (E.R.B.)

819 (NP-17444) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 6, Number 1. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Jan. 1968. 33p. Dep.

The problems involved in the application of international standards to radiation protection activities is reviewed in a general way. Solutions are not offered, rather the recommendations of the ICRP are examined in view of the Canadian situation in relation to nuclear activities. The areas discussed in the report include; the problem safety regulations for nuclear personnel, licensing of radioisotopes, public health action levels, population doses and dose apportionment, and the problem of medical exposure. Data are also presented in tabular form on the results of the Canadian fallout surveillance program. Included in the data are: total β activity in air and precipitation samples during 1966 to 1967; strontium-90 and cesium-137 content of whole milk and tap water during 1966 to 1967; total α and β activity in water from Ottawa River and Lake Huron; cesium-137, strontium-89, and strontium-90 content of water from Ottawa River, Lake Huron, and Winnipeg River; calcium, potassium, cesium-137, strontium-89, and strontium-90 content of whole milk from environs of Douglas Point Reactor Site and Whiteshell Nuclear Research Establishment; and total α and β activity in air samples from environs of McMaster University Reactor in Hamilton. (E.R.B.)

820 (NP-17579, pp IV.1-3) RADIOPHYSICAL CONTROL. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Total α and β activities and $^{89}Sr-^{90}Sr$ contamination of airborne dust and rain water samples taken at the Belgian Nuclear Studies Center and at four different locations in Belgium were measured. Cesium-137 and ^{90}Sr contamination of food samples taken all over the country were measured. Calcium, ^{137}Cs, K, ^{226}Ra, Sr, and ^{90}Sr were measured in samples of complete food rations taken at the Ecole des Cadets. Studies were conducted on contamination control of the Scheldt estuary. Results concerning dilution factors of soluble effluents were obtained by fluorescence techniques. Literature data and laboratory experiments showed that the use of ^{82}Br might be promising because of the high stability of Br ions in water. This method was tried using iron torpedos placed 1 meter below the water surface. The activity was continuously recorded. Atmospheric diffusion studies and routine meteorological observations were made. The study of correlation between atmospheric diffusion parameters and meteorological conditions is based on experiments with the vectorial anemometer Kirem and practical tests during which an aerosol of fluoresceine was released to the atmosphere. There was usually a fair agreement between the predicted and the measured values. (H.L.W.)

821 (NP-17579, pp IV.3-4) RESEARCH ON BODY CONTAMINATION. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Low level proportional counters were used for detection of α emitters, ^{241}Am, ^{242}Cm, ^{239}Pu, and ^{240}Pu in the lungs. Detection methods were studied for ^{242}Cm in urine, and ^{241}Am and ^{242}Cm in nose blow and feces samples. Uranium in urine was measured by α counting and fluorescence analysis. Radiotoxicity of ^{226}Ra taken up in the presence of sulfate ions was studied. (H.L.W.)

822 (ORNL-tr-2031) MEASUREMENT OF ABSORBED RADIATION ON SPACE FLIGHTS. Makhmudov, B. M. Translated for Oak Ridge National Lab., Tenn., from Vestn. Mosk. Univ., Ser. III. Fiz. Astron., 23: No. 2, 11-16(Mar.-Apr. 1968). 8p. Dep. CFSTI.

The results of various experiments to measure the absorbed dose of cosmic radiation during the flight of earth satellites and manned spaceships are presented and briefly discussed. (W.H.K.)

823 ^{137}Cs AND POTASSIUM IN CEREALS. Benes, Jaroslav; Fiser, Bohuslav; Tomasek, Milan (Inst. of Nuclear Research, Prague). Jad. Energ., 14: 334-7(1968). (In Czech).

The ^{137}Cs and potassium contents in wheat from the 1966 crop in Czechoslovakia were determined. The mean content of ^{137}Cs was found as 78.8 ± 9.2 pCi/kg, and of K as 7.01 ± 0.24 g of K_2O/kg. (auth)

824 GENERAL CONSIDERATIONS ON ACCIDENTAL IRRADIATIONS. Recht, P. (EURATOM). pp 407-25 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

A list of accidental irradiations is presented, and the general lessons to be drawn from them are discussed. Comments and suggestions for studies on the administrative and medical-legal aspects of accidental irradiations are included. (auth)

825 BIOLOGICAL MONITORING FOR DOSE ASSESSMENT FOLLOWING ACCIDENTAL INTAKE OF RADIOACTIVE MATERIALS. Dolphin, G. W. (UKAEA, Harwell, Eng.). pp 195-202 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

Some of the biological monitoring procedures which may be used for estimation of the dose following accidental intake of radioactive material are reviewed. The methods for direct measurement of the exposed worker and the measurement of the excreta are examined. The procedures used for estimation are shown to be dependent on the route of intake to the body which may be by inhalation, ingestion, or wound and also on the solubility of the radioactive material in body fluids. Both soluble and insoluble materials are investigated. (B.G.D.)

826 REVIEW OF ACCIDENTAL IRRADIATIONS WITH ACCELERATORS AND PROTECTIVE MEASURES AGAINST RADIATION. Joffre, H.; Vialettes, H. (CEA, Saclay, France). pp 437-55 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

After a brief review of radiation accidents with accelerators due to ignorance of personnel, carelessness of personnel, abnormal functioning of accelerators, malfunctioning of safety devices, and unspecified causes, the ways of limiting these accidents are discussed. (B.G.D.)

827 ASSESSMENT OF SKIN DOSE FROM CUTANEOUS CONTAMINATION. Breuer, F.; Casnati, E. (Centro di Studi Nucleari della Casaccia, Rome). pp 514-24 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

External dosimetry problems relating to cutaneous contamination by radionuclides are examined with particular reference to the consequences of irradiation to the skin itself. The calculations for evaluating the skin dose, the methods for assessing the consequences of contamination, and difficulties and uncertainties to be faced are briefly illustrated. (B.G.D.)

828 SKIN CONTAMINATION. Wijker, H. (Nuclear Reactor Lab., Arnhem, Netherlands). pp 571-94 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

A large number of problems which relate to radioactive contamination of both normal and damaged skin are discussed. These include prevention and limitation of the contamination, internal contamination resulting from cutaneous contamination, the dose to the skin as a result of contamination, the maximum permissible dose to the skin, the maximum permissible contamination of the skin, measurement of the contamination and determination of the dose on the basis of such measurements, decontamination, and treatment of wounds. (auth)

829 ACCIDENTAL IRRADIATION AT PLACE OF WORK. Proceedings of the International Symposium held in Nice, France, April 26–29, 1966. EURATOM, 1967. 688p. $21.00. (In several languages). (EUR-3666; CONF-660412).

Separate abstracts were prepared for fourteen of the nineteen papers presented. Five papers were previously included in NSA. For abstract numbers of these papers see CONF-660412 in the report number index. (B.G.D.)

For abstracts of individual papers see: 708, 824–828, 830–832, 858, 859, 915, 935, and 937.

830 LESSONS TO BE DERIVED FROM SOME IRRADIATION ACCIDENTS IN THE UNITED KINGDOM. Dunster, H. J. (UKAEA, Harwell, Eng.); Legge, I. K. pp 51-63 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

Radiological accidents, whether or not they result in excessive doses or injuries, are a fruitful source of information and the lessons learned from them can be valuable, not only in preventing simple repetition of the accidents but also in improving the overall control of radiological hazards. It must be remembered, however, that to learn a lesson from an incident is not to convert a failure into a success. Most of the lessons described could have been learned without the accident ever occurring. Indeed, many of them are based on common sense and general experience and were already familiar to the people involved in the accidents. In radiological protection, the emphasis should be in proper design, well-planned operation and, in the event of a fault condition developing, thought before action. (auth)

831 EXAMINATION OF CRITICALITY AND REACTOR ACCIDENTS IN THE UNITED STATES AND THE LESSONS TO BE DRAWN IN THE RADIOPROTECTION FIELD. Biles, M. B. pp 37-50 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

Descriptions of recent criticality and reactor accidents in the United States and evaluations of these accidents are presented. Procedures and recommendations for equipment and personnel for handling radiation accidents are included. (B.G.D.)

832 EARLY MEASURES IN THE CARE OF PERSONS ACCIDENTALLY OVER-EXPOSED TO IONIZING RADIATIONS. Duncan, K. P. pp 91-103 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

The principal actions which must be taken by health and safety staff during the first day or two after an incident severe enough to lead either to acute external radiation over-exposure, with or without complications, or to an intake of radioactive materials sufficient to carry a chance of excessive dose commitment are described. (B.G.D.)

833 PREDICTION OF BIOLOGICAL DAMAGE FROM STOPPING POWER THEORY. PART II. INCIDENT PHOTONS. Davy, D. R. (Australian Atomic Energy Research Establishment, Lucas Heights, New South Wales). Health Phys., 14: 569-79(June 1968).

A quantitative physical model, successful for predicting biological damage resulting from incident particles, is extended to cover x ray irradiations. The creation in the critical volume of the cell's nucleus of a carbon atom with a double bond opening was previously determined as a necessary and sufficient condition for biological damage. This can be induced by three types of interactions with incident x rays: An Auger cascade in the carbon atom following K-shell ionization by electron impact; disruption of two C–H bonds by the secondary electron swarm; and a Compton interaction disrupting one C–H bond with the specific Compton electron so produced disrupting the second C–H bond. The variation of each inactivation cross section is evaluated as a function of incident x ray energy, and the sum of the cross sections weighted to reported x ray spectra is used in the study of cell survival kinetics. Good agreement is found between theory and experiment for survival-levels greater than 0.2, but below this the theory underestimates the resulting damage, if compared with experimental survival data that classes a very slow-growing clone as nonviable. Recent results show that a reversal of this criterion leads to good agreement for survival levels greater than 0.01, but for lower survival levels a discrepancy may still exist. Possible reasons for such a discrepancy are discussed in terms of the necessary and sufficient postulate of the model, this behavior of x rays being contrasted with that of incident heavy charged particles. (INIS) (UK)

834 RADIATION DOSIMETRY AND ITS APPLICATION TO THERAPY OF UTERINE CANCER. van Cura, Lawrence J.; Kenney, Gordon N. (Univ. of Wisconsin, Madison). Clin. Obstet. Gynecol., 10: 974-1002(Dec. 1967).

A discussion is presented on the instrumentation employed in the experimental measurement of radiation doses and the calculation of radiation distribution by the use of digital computers. Principles of operation and limitations of detectors commonly used to measure radiation in intracavitary and external beam radiotherapy are examined with particular emphasis on intracavitary dosimetry. The problem of calculating the radiation distribution about a number of intracavitary sources can be handled for each specific case by a general Fortran computer program, which requires that the types of sources, their strengths (activity), and their positions relative to coordinate system be specified. The radiation sources used for treatment of uterine cancers emit γ rays with energy in the 0.2 to 2.0 MeV range. The calculation of a radiation distribution resulting from primary radiation in an inhomogeneous medium is discussed. The ability to relate the calculated doses to the body structure is limited. (TSS)

835 THE PROBLEM OF THE MOST SUITABLE RADIATION TREATMENT OF HEMANGIOMAS (EXPERIENCES WITH 2000 HEMANGIOMAS). Breit, A. (Staedtische Krankenhaus, Passau, Ger.). Hautarzt, 17: 208-13(May 1966). (In German).

Radioprotection during treatment of hemangiomas with $^{90}Sr-^{90}Y$ applicators is described and discussed. Measurements of bremsstrahlung from a 100-mCi $^{90}Sr-^{90}Y$ applicator indicate that, laterally, at distances of 10, 20, and 30 cm the dose intensities are 360, 100, and 11 mR/hr. At similar distances located above the applicator, the dose intensities are 77, 22, and 6 mR/hr, respectively. Considering the short irradiation times used with a 50- or 100-mCi applicator, these values indicate that the irradiation hazard is low. However, even though the dose to medical personnel is low

during this type of treatment, amounting to ~0.4 mR at a distance of 4 cm when 4000 R are given, this value may be significant when taken into account with other irradiation to which personnel may be exposed. Complete protection from an applicator with radiation characteristics of 1.65 mm of Cu half-value layer can be ensured by use of a portable shield with a 2-mm Pb equivalent. (BBB)

836 CONTAMINATION: REMOVAL, CONTROL, PREVENTION. Easley, Charles W. (California Inst. of Tech., Pasadena). J. Amer. Soc. Safety Eng., 13: 11-13(Feb. 1968).

The problems of radioactive contamination in industrial and research areas are reviewed. A definition of contamination requiring treatment is given and types of contamination and their prevention are discussed. The decontamination methods discussed are decay, shielding, and removal and controlled disposition. Specific solutions for some of the common or more difficult problems in decontamination are given. It is stressed that decontamination is no substitute for advance planning. (C.O.)

837 RADIOSTRONTIUM CONTENT OF DECIDUOUS TEETH. Cigna, A. (CNEN, Rome); Esposito, U.; Mariani, A.; Tomassi, G. Quad. Nutri., 27: 163-70(1967). (In Italian). (RT/PROT-(67)18).

^{90}Sr contamination in deciduous teeth of children born in Rome between 1954-59 has been studied in relation to breast or bottle feeding. ^{90}Sr has been determined on samples of at least 10 g of teeth, predominantly molars and cuspids, and therefore calcified more than 80% after birth. Results show a lower radiocontamination in teeth from breast-fed children (on the average 27% lower) than bottle-fed children, emphasizing the protection exerted by breast feeding on ^{90}Sr contamination during the first months of life. (auth)

838 RAPID DETERMINATION OF ^{137}Cs IN VETERINARY CONTROL SAMPLES. Kruglikov, B. P.; Sarbash, A. N.; Gimmel'farb, F. B. Veterinariya, No. 4, 104-5(1967). (In Russian).

The method is applicable to soft tissue, milk, and materials of plant origin. The sample is ashed in HNO_3 vapor at 400° to 450°, the ash is treated with 30% aq. $H_2O_2-HNO_3$ (1:1), and carrier Cs (60 to 100 mg) is added to the white residue; if the sample contains only a little Ca, then CaO (200 to 300 mg) is added. The white mixture is treated with aqua regia (5 ml per g of ash), the solution is evaporated on a steam bath, then evaporated with HCl, and the residue is dissolved in H_2O plus HCl (a few drops). The filtered solution is diluted to 250 ml with H_2O and heated nearly to b.p., then saturated ammonium carbonate solution is added, and ^{90}Sr is determined in the ppt. To the filtrate from this precipitation is added concentrated HCl (10 ml), the solution is evaporated to dryness, and the residue is calcined at 300° to remove ammonium salts and dissolved in concentrated HCl (20 to 50 ml). Cesium is precipitated as Cs_2TeCl_6 by adding a 10% solution of TeO_2 in concentrated HCl; after 16 hr. the solution is decanted and the precipitate is dissolved in hot 2N-HCl. This solution is filtered and evaporated to a small volume then concentrated HCl (20 to 50 ml) is added, and after a few hours the solution is decanted. The precipitate of Cs_2TeCl_6 is washed twice with concentrated HCl, three to five times with acetone and once with 96% ethanol, then dried for 1 to 2 hr at 140°. The dry precipitate is weighed to determine Cs and the radioactivity of the ^{137}Cs is measured. (Referativnyi. Zh.)

839 RADIATION DOSE FROM HIGH-ENERGY NUCLEONS IN TARGETS CONTAINING SOFT TISSUE AND BONE. Turner, J. E.; Anderson, V. E.; Wright, H. A.; Snyder, W. S.; Neufeld, J. (Oak Ridge National Lab., Tenn.). Radiat. Res., 35: 596-611 (1968). (ORNL-p-3661).

Previous calculations for nucleons with energies up through 400 MeV incident on homogeneous soft tissue targets were extended to phantoms in which bone was also present. Estimates of absorbed dose and dose equivalent are given for targets of dimensions approximating those of the human torso and a small primate. With incident protons, the presence of bone in the soft tissue is apparently of little consequence, since the absorbed dose and dose equivalent are nearly the same with and without bone. With incident 400-MeV neutrons, however, the ratio of the dose equivalent and absorbed dose in the bone portions is found to be about 20% smaller than when the bone region is occupied by soft tissue. The reduction in the quality factor in bone for neutrons is due to the relatively smaller contribution of high-LET particles to the absorbed dose there. High-LET particles arise in the calculation as recoil nuclei following an intranuclear cascade and as low-energy evaporated heavy nuclear fragments (for example, alpha particles). Relative to soft tissue, the larger nuclei in bone apparently do not, on the average, transform as much of the incident nucleon energy per unit mass into high-LET products. Details are shown for 400-MeV neutrons incident on a small cylinder. Whereas recoil nuclei (exclusive of hydrogen) and heavy evaporated fragments contribute ~35% of the absorbed dose in soft tissue, they contribute only ~27% in bone. Results are summarized for 400-, 250-, and 100-MeV neutrons and protons incident on small and large targets. (auth)

840 COURSE ON RADIATION PROTECTION IN INDUSTRY. Occupational Safety and Health Series No. 11. Geneva, International Labour Office, 1967. 266p. (NP-17447).

Topics discussed in this text book for industrial safety personnel include the following: basic phenomena of radiation and radioactivity; radiation dose units, their detection and measurement; production of radioisotopes and x rays; medical uses of radiation; radiation shielding; industrial radiography using radioisotopes and x rays; genetic and somatic effects of radiation; ICRP and other recommendations, regulations, and standards regarding use and exposure to ionizing radiation; external and internal radiation hazards; contamination control and laboratory design; radioactive waste disposal hazards and protection against them; radiation protection during transport of radioactive materials; instruments for radiation control; and factory inspection for radiological protection. Five laboratory exercises are included at the end of the text. (E.R.B.)

841 RADIATION EXPOSURE OF URANIUM MINERS. PART I. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETIETH CONGRESS, FIRST SESSION, MAY 9, 10, 23, JUNE 6, 7, 8, 9, JULY 26, 27, AND AUGUST 8 AND 10, 1967. Washington, D. C., Joint Committee on Atomic Energy, 1967. 828p. GPO $2.25.

842 FEDERAL RADIATION COUNCIL PROTECTIVE ACTION GUIDES. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION, JUNE 29 AND 30, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 702p. GPO

843 PROPOSED LEGISLATION RELATING TO UNIFORM RECORD-KEEPING AND WORKMEN'S COMPENSATION COVERAGE FOR RADIATION WORKERS. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, SECOND SESSION, AUGUST 30, 31, SEPTEMBER 20, 21, AND 22, 1966. Washington, D. C., Joint Committee on Atomic Energy, 1966. 848p. GPO $2.50.

844 MICROSCOPIC RADIATION QUANTITIES. Rossi, Harald H. (Columbia Univ., New York). Radioprotection, 3: 143-8(1968).

The physical quantities ordinarily used in relation to ionizing radiation are macroscopic in that they represent averages over large numbers of particles and absorption events. However, many radiation effects and in particular cellular radiobiological effects are often due to the action of very few particles and frequently only due to one particle. Under these conditions the microscopic quantities which specify the energy concentrations actually existing can differ greatly from their macroscopic counterparts. Among possible microscopic quantities the local energy density and the event size are defined and their inter-relation is discussed. Brief reference is made to experimental determinations of event size distributions with walled and wall-less proportional counters. A number of ways are considered in which microdosimetric quantities can be employed in theoretical radiobiology. (auth)

845 CAUSES OF ACCIDENTS NEAR SOME ACCELERATORS AND PREPARATIONS FOR RADIOPROTECTION. Joffre, Henri; Vialettes, Henry (CEN. Saclay, Gif-sur-Yvette, France). Radioprotection, 3: 81-96(1968). (In French).

Some typical accidents mentioned in bibliographies or that happened in C.E.A. Research Centers are presented. The accidents are analyzed to pinpoint the main cause and get some experience. The usefulness of a centralized control for security, detection and signaling devices used near every important accelerator was also studied. (auth) (TSS)

846 γ-SPECTROMETRIC MEASUREMENTS OF ^{137}Cs BY AN AIRCRAFT DURING GLOBAL RADIOACTIVE CONTAMINATION. Boltneva, L. I.; Ionov, V. A.; Kogan, R. M.; Nazarov, I. M.; Chirkov, V. P.; Yakovlev, A. F. Izv. Akad. Nauk SSSR, Fiz. Zemli, No. 10, 64-70(Oct. 1968). (In Russian).

Descriptions are given of the measuring methods and their accuracy. Data obtained by γ spectrometric studies of contaminated aerable soil and swamps are analyzed. Gamma radiation from ^{137}Cs in the air was evaluated and compared to the amount of ^{125}Sb and ^{54}Mn. It was found that effective measurements of ^{137}Cs (0.1

Ci/km^3) from the aircraft can be obtained at elevations not exceeding 50 m. (R.V.J.)

847 MEASUREMENTS OF THE PERMEATION RATE OF TRITIATED HEAVY WATER THROUGH POLYMERIC FILMS, AND SAFETY EVALUATION OF PROTECTIVE CLOTHING AND GLOVES MADE OF POLYMERIC FILMS. Katoh, Jinzo; Ohuchi, Masafusa (Japan Atomic Energy Research Inst., Tokyo). Hoken Butsuri, 3: 288-94(June 1968). (In Japanese).

In handling radioactive materials, various kinds of protective clothing made of polymeric films are employed for protection of radioactive contamination. The permeation rate of tritiated heavy water and its vapor through polymeric film, such as PVC, polyethylene, and rubber was measured by using an ionization chamber with a vibrating reed electrometer. On the basis of the results obtained, internal exposure of the person wearing the protective clothing is evaluated and discussed. (NSA of Japan)

848 ^{90}Sr AND ^{137}Cs IN STOCK RAIN WATER FOR DRINKING SAMPLED AT BEACON LIGHTHOUSES DURING 1962, 1963, AND 1964. Nagasawa, Kakuma; Urakubo, Goro; Kametani, Katsuaki; Kido, Yasumasa; Ikebuchi, Hideharu (National Inst. of Hygienic Sciences, Tokyo). Eisei Shikenjo Hokoku, 84: 29-34(1966). (In Japanese).

Samples of potable rain water used by the residents of beacon lighthouses were collected once a month during the period from April, 1962 to March, 1963 and once every other month during the period from April, 1963 to March, 1964. Assays of ^{90}Sr and ^{137}Cs were carried out on filtered and unfiltered samples. Methods of filtering the rain water and radiochemical separation procedures for ^{137}Cs and ^{90}Sr were outlined. The lighthouses were located at 12 different sites along the shores of the Japanese islands. The annual mean value of the radionuclide concentration in filtered water in 1962 and 1963 were 3.18 and 4.06 pCi/l for ^{90}Sr, and 0.79 and 0.76 pCi/l for ^{137}Cs, respectively. In comparison, it was reported that the annual mean values of daily intake of ^{90}Sr from the total diet of Japanese urban adults in 1962 and 1963 were 9.85 and 13.28 pCi/day/person. Thus, the calculated daily intake of ^{90}Sr of the people who were using the filtered rain water for drinking was ~70% more than that of the urban adult population of Japan. The mean values of ^{90}Sr dietary intakes were tabulated for 24 cities in Japan for 1962 and 1963. (BBB)

849 HEALTH DEPARTMENT INVESTIGATION SHOWS DECREASE IN X-RAY RADIATION HAZARD. N. Y. J. Dent., 38: 101-2(Mar. 1968).

The danger of overexposure to radiation from medical and dental x-ray examinations in New York City decreased over 70% in the past nine yr according to the Health Department's Office of Radiation Control. The chances of overexposure due to poor x-ray techniques and faulty equipment were reduced by an intensified inspection and evaluation program of medical and dental units begun in 1958. It was reported that 8322 or 75% of the 11,400 medical x-ray machines and fluoroscopes in use in the city now met Health Department regulations. In 1959 only 8% were found to be satisfactory. A major fault in x-ray equipment remedied in the past decade was the lack of filters to screen out x-rays of such low energy that they could not pass through the patient's body to reach the photographic plate. The danger there was of overexposure of the skin. Recent inspection showed that 96% of dental x-ray units and 95% of the city's medical x-ray units were equipped with adequate filters, compared to only 71% in 1958. Many x-ray units failed to meet Health Code regulations in 1958 because they did not limit the size of the x-ray beam to the part of the patient's body under study. Correction of this problem alone tripled the number of x-ray machines that now meet Health Department standards. (BBB)

Medicine

Refer also to abstracts 141, 604–606, 612, 626, 657, 661, 664, 776, 777, 781, 786, 791, 835, 904, 929, 932, 933, 936, 939–944, 946, 947, and 1728.

850 (ABCC-66-67(Suppl.)) RESEARCH PROTOCOLS, JULY 1, 1966–JUNE 30, 1967. (Atomic Bomb Casualty Commission, Hiroshima (Japan)). 371p. (In English and Japanese). Dep. CFSTI.

For Annual Report see ABCC-66-67.

Contained within this supplement to the progress report of the Atomic Bomb Casualty Commission (ABCC) are the research protocols for current research projects operating within the scope of the ABCC. Reports are presented on 63 projects in the areas of dosimetry, mortality, morbidity, growth and development, epidemiology, neoplasms, genetics, aging, pathology, parasitology, and hematology. In all studies reported, the emphasis is on a medical and statistical comparison of the groups exposed to the atomic bombing of Hiroshima and Nagasaki with nonexposed groups or exposed groups lacking acute radiation symptoms. (E.R.B.)

851 (JPRS-43628) PROPHYLACTIC EFFECT OF AMINOETHYLISOTHIOURONIUM BROMIDE HYDROBROMIDE (AET) IN COMBINATION WITH BEE MILK IN ACUTE EXPERIMENTAL RADIATION SICKNESS. Boyadzhiev, S.; Peychev, P.; Marovski, T. Translated from Rentgenol. Radiol., 6: 190-3 (1967). 6p. CFSTI.

Bee venom was injected intramuscularly into mice and rats every day for four days prior to x irradiation. AET was injected intraperitoneally 30 min before irradiation. Control animals were injected with physiological saline. The death rate of mice and rats treated with bee venom and AET did not differ from that of controls. The longevity of mice treated with AET alone was increased. Rats treated with AET and bee venom or with AET alone recovered weight more rapidly. It was concluded that bee venom did not increase the radioprotective effect of AET in radiation sickness for mice and rats. (H.L.W.)

852 PHARMACOLOGIC STUDY OF A NEW ANTI-INFLAMMATORY ANALGESIC COMPOUND, GLAPHENINE. Peterfalvi, M.; Branceni, D.; Azadian-Boulanger, G.; Chifflot, L.; Jequier, R. (Centre de Recherches Roussel-Uclaf, Romainville, France). Med. Pharmacol. Exp., 15: 254-66(1966). (In French).

The effect of a new drug, 4-[2′-(β,γ-dihydroxypropoxycarbonyl)-phenylamino] 7-chloroquinoline or glaphenine, on uv-induced erythema was studied. In uv irradiation tests, albino guinea pigs, weighing 600 to 900 g, were exposed at a distance of 200 cm from a 500-W mercury vapor lamp for two min. Three 8 mm diameter areas of epilated skin were exposed one hr after oral administration of the drug. Two hr after irradiation, the intensity of erythema was evaluated. The drug was about as effective as aspirin in preventing uv-induced erythema. It could be prevented in about half of the animals by doses of 50 mg/Kg. Glaphenine also showed pronounced analgesic activity in the acetic acid stretching test in mice and the Randall and Selitto test in rats. In these tests, it was five and 10 times as active as aspirin, respectively. The compound also exhibited anti-inflammatory activity in the naphthoyl-heparamine foot edema test in rats. Moreover, it had antipyretic and antiexsudative properties. Its acute toxicity was weak. In the mouse the oral LD_{50} is 3.5 g/Kg. No pharmacodynamic effect was observed on the central or autonomic nervous system, heart, or respiratory function. (BBB)

853 EFFECT OF TANDERIL ON WHITE MICE EXPOSED TO X RAYS. Dega, Kazimierz; Ulewicz, Kazimierz; Klajman, Stanislaw; Michniewski, Przemyslaw; Twardowska, Irena; Zawistowski, Stanislaw (Academy of Medicine, Danzig). Przegl. Lek., 22: 299-301(1966). (In Polish).

The anti-inflammatory action of Tanderil in mice exposed to x rays was investigated in 195 animals of strain CWF, weighing 20 to 25 g. An x radiation dose of 500 R was given at 170 KV at a dose rate of 35.3 R/min. Mice were divided into four groups, one of which received 500 R without Tanderil (1-phenyl-2-p-hydroxyphenyl-3,5-dioxy-4-n-butylpyrazolidine); of this group 34% died within 41 days. Another group received 500 R and an injection of 0.375 mg of Tanderil; 6% of these mice died in the same time period. Body temperature in the mice was observed to be lower (37.8°C rather than 38.4°C) in the group receiving Tanderil before irradiation. Two other groups were given Tanderil alone and placebo alone. Blood cell counts were taken and bacteriological studies were made. It was concluded that Tanderil had both an anti-inflammatory and an antifebrile effect that contributed to lessening the general stress reaction provoked by x rays. (BBB)

854 EFFECT OF TANDERIL ON ACUTE POSTIRRADIATION DISEASE. Dega, Kazimierz; Ulewicz, Kazimierz; Klajman, Stanislaw; Michniewski, Przemyslaw; Meyze, Bernard (Academy of Medicine, Danzig). Przegl. Lek., 23: 403-5(1967). (In Polish).

The antipyretic and anti-inflammatory action of Tanderil during development of radiation sickness in mice was investigated. Two series of experiments were conducted in 408 animals weighing 20 to 25 g, subdivided into four groups for each series. Two groups received 800 R (LD_{50}) of x irradiation at 170 kV. Two groups received 800 R of x rays and an injection of 0.375 mg of Tanderil (1-phenyl-2-p-hydroxyphenyl-3,5-dioxy-4-n-butylpyrazolidine). In the first series of experiments Tanderil was administered on the third day after irradiation; at the end of 30 days 35 of the 45 mice in the group were dead (78%). In the second series of experiments Tanderil was administered for three successive days after irradiation; 36 out of 58 mice died within 30

days (62%). Two groups each received Tanderil and placebo injections. It was concluded that, because of its antipyretic and anti-inflammatory effect, Tanderil was a valuable therapeutic agent in radiation sickness. (BBB)

855 ACTION OF TRIHYDROXYETHYLRUTOSIDE ON INFLAMMATORY REACTIONS. Van Caneghem, P. (Univ., Liege). Dunjic, A.; Stein, F.; Pesesse, M. P. Pathol. Eur., 2: 118-23 (1967). (In French).

A study was made to determine whether it was possible to modify in animals, under conditions more easily standardized than with man, the pattern of cutaneous reactions to x rays by use of trihydroxyethylrutoside (THER), vitamine P_4, after irradiation. Albino mice weighing 20 g were used. Before irradiation, 0.1 ml/10 g body weight of a solution of THER (40 mg/ml of physiological saline) was injected intravenously into 45 rats. After 15 min an intravenous injection of 0.1 ml of chlorazol blue solution was given and 15 min later 0.1 ml solution containing cystamine was injected in one back paw and a solution without cystamine in the other paw. The animals were subjected to doses of x irradiation varying from 1000 R to 10,000 R. Once a day following irradiation, they received 0.1 ml/20 g of the same THER solutions for 15 days. Local reaction of the irradiated paws was observed for a period varying from 24 hr for acute reactions to 5 weeks to follow the late reactions. Despite the variation in doses and the repeated injections of THER, no inhibition of the early inflammatory reaction was observed, no diminution of a later exudative reaction, nor any modification of repair phenomena. (BBB)

856 SURVIVAL RATE OF IRRADIATED RATS AFTER TREATMENT WITH PLATELET LIPID EXTRACTS ALONE AND IN COMBINATION WITH AN ANTIFIBRINOLYTIC AGENT. de Nicola, P.; Luescher, E. F.; Coppi, M.; Montanaro, G. (Univ., Pavia, Italy). Vox Sang., 14: 224-7(Mar. 1968).

An investigation was carried out in normal and x-irradiated rats on the effects of platelet extracts on their survival time. On the first day 1000 R (120 KV) was administered, followed by 200 R on the 6th and 8th day (220 KV). Platelet lipid extract was prepared from washed human platelets submitted to mechanical homogenization. After centrifugation for 30 min at 1500 g, the sediment was lyophilized and the lipids were extracted with a 2:1 (v/v) mixture of chloroform-methanol. After evaporation of the solvents and drying (70°C), the residue was dissolved in ethanol. Water and acetone were then added, and from the dried precipitate, which was essentially phospholipid, a 1% emulsion in a 3% isotonic albumin solution was prepared. This extract (platelet extract L) was administered intravenously in daily doses of 0.2 ml for 6 days. The parotid inhibitor, Trasylol, was used as an antifibrinolytic agent in daily doses of 10 units administered intravenously for 6 days. Survival rate of irradiated, treated rats was higher than that of irradiated, untreated animals. When platelet lipids alone were used, 14 rats of the treated group were still alive when all of the untreated group were dead. A still greater percentage of the animals survived when platelet lipids were administered in combination with the antifibrinolytic agent Trasylol. With this combination, the 19 surviving rats remained alive for more than 14 days after the death of all the untreated animals. (BBB)

857 MEASUREMENT OF PEAK VOLTAGE OF DIAGNOSTIC X-RAY GENERATORS. Davison, M.; Reekie, D. (Western Regional Hospital Board, Glasgow). Phys. Med. Biol., 13: 643-51 (Oct. 1968).

The measurement of the voltage of diagnostic x-ray generators, using the characteristic radiation emitted by scattering foils, is discussed, and a rigorous definition of the generator voltage which just equals that of the K-absorption edge is presented. Previous methods of defining this voltage are shown to be either wrong or subject to random variations of up to 10%. Experimental evidence using a scintillation counter and multi-channel analyser is given in corroboration. The use of ionization chambers is also discussed and it is shown that reasonable accuracy (±1%) can be obtained using a single chamber to detect the characteristic radiation. The need for a differential filter of the same material as the scattering foil is considered, and evidence is presented to show that it can be replaced by a primary beam filter of aluminium of suitable thickness for the kilovoltage range under consideration. (auth) (UK)

858 ORGANIZATION OF ASSISTANCE AND TREATMENT FACILITIES. Jammet, H. (CEA, Paris). pp 631-47 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

The organization of treatment facilities at the place of work itself was first considered. A study was then made of the organization of facilities to be used in a hospital. Finally, the cooperation that must exist between the establishment and the hospital is examined. (B.G.D.)

859 TREATMENT OF SUBJECTS ACCIDENTALLY IRRADIATED IN TOTO. Mathe, G.; Schwarzenberg, L.; Amiel, J. L. (Institut de Cancerologie et d'Immunogenetique, Villejuif, France). pp 529-43 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

The primary consequences of acute whole-body irradiation in man are reviewed, confining to those which endanger the subject's life and consequently dictate the type of therapy. The principal therapeutic aids are listed and their indications summarized. The importance of platelet and leukocyte transfusions, keeping patients in aseptic conditions, and exercising caution in the use of antibiotics is emphasized. The effectiveness of allogenic bone-marrow transfusions is evaluated. (B.G.D.)

860 PREOPERATIVE IRRADIATION OF OSTEOGENIC SARCOMA WITH INTRA-ARTERIALLY INJECTED ^{90}Y MICROSPHERES. CASE REPORT. Simon, Norman; Siffert, Robert; Baron, Murray G.; Mitty, Harold A.; Rudavsky, Amiel (Mount Sinai Hospital, New York). Cancer, 21: 453-5(Mar. 1968).

Plastic microspheres containing yttrium-90 were injected intra-arterially into an osteogenic sarcoma of the femur to administer preoperative irradiation. Bremsstrahlung scans showed radioactivity localized in tumor and lungs. Specimens from the sarcoma and adjacent normal tissue were assayed for radioactivity and dose administered, about 2800 rads to the tumor and 100 rads to the adjacent skin. This method of preoperative irradiation merits further investigation. (auth)

861 INFLUENCE OF AET ON LOACH EMBRYOS, MISGURNUS FOSSILIS, UNDER THE ACTION OF γ-RAYS AND RADIOTOXINS. Neustroev, G. V.; Kondratenko, V. G.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya, 8: 588-93(1968). (In Russian).

A study of the influence of a protector (AET) on the survival rate and the appearance of deformities in developing embryos of Misgurnus fossilis under the action of various doses of γ-rays and concentrations of quinoid radiotoxins, indicated that the protective influence of the protector depends upon the mode of its administration. In the case of therapeutic use, AET is an ineffective protector; prophylactic administration of the protector, however, leads to a pronounced effect. The effect of protection depends upon a number of factors: the dose of γ-rays or concentration of radiotoxins; the phase of the cellular cycle during the process of cleavage at which the influence was imposed. It is hypothesized that the protective influence of the protector under the action of γ-rays is associated with inactivation of radiotoxins. (JPRS)

862 CLINICOSTATISTICAL CONSIDERATION ON THE TREATMENT OF 78 ESOPHAGEAL CANCERS BY TELECOBALT THERAPY. Guzzon, Adalgiso; Milani, Franco; Volterrani, Fabio (Instituto Nazionale per lo Studio e la Cura dei Tumori, Milan). Tumori, 54: 161-74(Mar.-Apr. 1968). (In Italian).

Clinical results and complications observed in 78 inoperable esophageal cancer patients subjected to telecobalt therapy at the National Cancer Institute, Milan, between June 1958 and June 1966 are reviewed. All 78 patients received a curative dose, that is, over 4000 rad to the tumor. The anatomical, clinical, and x-ray data are shown in tables. The technical data and dose levels are discussed. There were 23 patients who survived for over a year; the average survival for the whole series was a little under 10 months. The most effective dose was thought to be about 6000 rad given over 2 months. Severe complications included 1 fatal case of esophageal perforation, in which a 4000-rad dose had been given. Another patient developed similar problems 5 months after receiving a 6800-rad focal dose. Radiation pneumonitis which cleared rapidly was seen in some patients, but residual lesions of interstitial fibrosis of the lungs had not yet developed during the short follow-up period. In a patient who had received a 5600-rad local dose through 2 opposing fields 20 months earlier, thoracic spinal injury was evident from the left lower paresis that developed. (BBB)

863 PELVIC LYMPHNODECTOMY AS AN ADJUNCT TO THE RADIATION THERAPY OF CERVICAL CARCINOMA. Morton, Daniel G.; Lagasse, Leo D. (Univ. of California, Los Angeles). Clin. Obstet. Gynecol., 10: 965-73(Dec. 1967).

Effectiveness of and complications from removal of the regional pelvic lymph nodes following radiation therapy for cervical cancer were evaluated. A study of the removed irradiated tissues was also carried out. Radiotherapy involved local Ra applications, usually divided into 2 doses, and external ^{60}Co or ^{137}Cs therapy to the parametria and lymph node-bearing areas. The doses achieved

were 8000 rad to point A, 4500 rad to point B, and 12,000 to 20,000 rad to the cervical canal proper. When the radiation preceded the lymphnodectomy, about 8 weeks elapsed. Of 103 patients who underwent transabdominal lymphnodectomy, complications serious enough to require another surgical procedure occurred 14 times in 13 patients. The most common complication was lymphocyst formation, which was seen in 6 patients (5.8%) and required surgical drainage in 5. There were no surgical injuries to the bladder or ureter, but 3 patients developed noncancerous rectal and/or bladder fistulas 6 to 12 months after treatment, due to the irradiation. These required fecal or urinary diversion. There were no ureterovaginal fistulas. Whether lymphnodectomy contributed to the late complications is uncertain. Mild leg edema was common in the first 2 to 4 months but unless there was a persistence or recurrence of tumor the edema subsided. (BBB)

864 ESOPHAGEAL CARCINOMA. RESULTS OF TELECOBALT THERAPY IN COMPARISON TO CONVENTIONAL X-RAY DEPTH THERAPY. Eichhorn, H. J.; Rotte, K. H. (Robert-Roessle-Klinik, Berlin-Buch, Ger.). Med. Klin. (Munich), 61: 539-42(Apr. 8, 1966). (In German).

Complications resulting from irradiation of 74 patients having esophageal carcinomas with average focal doses of 7500 R of telecobalt irradiation included 8 perforations of the mediastinum or tracheobronchial system, a frequency of ~9%. Of 31 patients treated for esophageal carcinoma by average doses of 6900 R of 200 kV x irradiation, 2 developed perforations. This represented a frequency of ~6%. The relation between perforation development and treatment with high doses of irradiation has been discussed in various reports, and the concensus of opinion is that most of the perforations are not due to the radiation destruction of the wall tissue that is still intact. Instead, perforations may be due to presence of a tumor that penetrates through the wall tissue. A defect or perforation results if connective tissue regeneration does not occur or the tissue wall is not properly prepared for repair before the tumor is destroyed. (BBB)

865 SIGNIFICANCE OF HIGH-ENERGY RADIATION IN THE THERAPY OF GYNECOLOGICAL TUMORS. Vieten, H.; Heinzler, F. (Univ., Duesseldorf). Geburtsh. Frauenheilk., 26: 1-16(Jan. 1966). (In German).

Tissue dose distributions with various radiotherapy sources are examined and the incidence of radioinjuries and their prevention by proper choice of sources are discussed. Differences and advantages of supervoltage (^{60}Co and megavoltage x-ray) irradiation compared to conventional depth and semidepth radiotherapy are discussed. The advantages of supervoltage methods are due to the high depth dose, the lack of natural scatter resulting in a sharp delineation of the beam, and homogeneous absorption in various tissues. This third advantage is a decisive factor in the radiotherapy of inhomogeneous regions of the body such as the pelvic organs and their osseous surroundings. Even if it were possible to deliver a sufficient tumor dose in the pelvis with all types of radiation, the pelvic bones would still receive a much higher dose of radiation when a 200-kV, orthovoltage x-ray source is used than when a 15-MeV x-ray source or a ^{60}Co γ-ray source is used. Even if the possible bone damage is disregarded, any excess irradiation constitutes an unnecessary stress on the hematopoietic system. In the treatment of gynecological tumors fast electron beams are much less useful than super- and mega-voltage x rays and γ rays. Electron generators are indicated in semideep therapy for which they are the radiation source of choice. The difficulties encountered in deep therapy with accelerated electrons of even high energy are mentioned. (BBB)

866 INITIAL EXPERIENCE WITH TECHNETIUM CEREBRAL SCANNING. Morley, J. Barrie; Sephton, R. G. (Prince Henry's Hospital, Melbourne). Med. J. Aust., 1: 433-7(Mar. 16, 1968).

The advantages and techniques of using ^{99m}Tc for brain scanning are reviewed and discussed. Experience with ~450 ^{99m}Tc brain scans is summarized. On the bases of technical quality of the result and the irradiation dose to the patient, ^{99m}Tc is generally accepted as the most suitable radioisotope currently available. Since ^{99m}Tc has a physical half life of only 6 hr the patient retains the radioactivity for a relatively short time. The technique used in administration is discussed. (TSS)

867 DIAGNOSIS OF LIVER DISEASE BY RADIOISOTOPE SCANNING. Chao, Hui-yang; Yang, Yung-chang; Lin, K'o-chien; Chiang, Ch'ang-ying; Ch'en, K'o-ching. Chung Hua Nei K'o Tsa Chih, 11: 675-9(1963). (In Chinese).

Fifty-eight cases of liver disease were examined by radioisotope scanning with the use of colloidal ^{198}Au in 44 cases and Rose bengal-^{131}I in 14 cases. Twenty-two cases were of primary carcinoma of the liver, 3 of metastatic carcinoma of the liver, 6 of benign space-occupying lesion of the liver, 15 of cirrhosis of the liver, 4 of chronic hepatitis and 2 of extra-hepatic disease, while the remaining 6 cases were normal. The morphology, structure, localization and size of the liver could be seen on the scanning gram. This method of examination is particularly valuable in the diagnosis of space-occupying lesions of the liver and in the differential diagnosis of suspected cases of this nature, and none in the present series, which were all positive on the scan, was misdiagnosed. However, the possibility of such a lesion cannot be excluded when the results prove to be negative. In the case of non-space-occupying disease, such as cirrhosis of the liver and hepatitis, certain changes will appear on the scanning, but, in general, the diagnostic value is relatively small. The following factors will determine whether it is possible to visualize the space-occupying lesions of the liver on the scan: the size localization of the lesion; and the resolution and sensitivity of the exploratory apparatus. The diameter of the lesion must be larger than 3 cm before it can be detected. Moreover, lesions too deeply situated or too close to the diaphragmatic surface or protruding out of the surface of the liver can barely be spotted. (JPRS)

868 DETECTION AND LOCALIZATION OF BONE METASTASES WITH ^{85}Sr. Sanguineti, Michele (Istituto di Radiologia e Medicina Nucleare degli Ospedali Galliera, Genoa). Tumori, 54: 175-84(Mar.-Apr. 1968). (In Italian).

The detection and localization of bone metastases by bone scanning with ^{85}Sr were studied in 58 patients for an evaluation of this diagnostic method compared with other radiologic methods. Results showed that scanning, especially if preceded by profile counting, is superior to x-ray techniques because it ensures early diagnosis; it reveals whether metastases are uni, pauci-, or multi-focal; and it accurately defines the size of the field to be irradiated. Selection of patients for ^{85}Sr treatment is discussed. Its relatively long physical half-life (64 days) and longer biological half life (~800 days) limits its use, and requires use of small doses. However, it provides an important means of assessing the extent and sites of metastatic bone cancer and aids in planning treatment. (BBB)

869 ESTIMATION OF ORGAN DEPTH BY A DOUBLE ISOTOPE TECHNIC. Dolan, Charles T.; Tauxe, W. Newlon (Mayo Clinic, Rochester, Minn.). Amer. J. Clin. Pathol., 50: 83-8(July 1968).

A method to estimate organ depth by comparison of the ratio of count rates from a doubly-labeled radioisotope compound with a standard curve, derived from phantoms, is described. Count rates from ^{125}I and ^{131}I are compared for various depths and locations within phantoms of various thickness. Results of calculations of estimated depths are compared with theoretical values. Effects of background radioactivity on count rate ratios are evaluated for several phantoms. Possible applications of this estimation technique to measurement of kidney depth and to measurements of thyroid and liver are suggested. Similar approaches to depth estimation with other pairs of radionuclides which concentrate in the same site but which have dissimilar γ-ray energies, and with a single radionuclide that emits γ rays of suitably different energies may be developed. (BBB)

870 BRAINSCANNING WITH RADIOINDIUM. Burrows, E. H. (Wessex Neurological Center, Southampton, Eng.); Kimber, P. M.; Goddard, B. A. Brit. Med. J., 1: 29-30(Apr. 6, 1968).

In the small scan series reported here the close parallel between the information obtained with ^{113m}In and ^{197}Hg justifies optimism for the routine use of ^{113m}In. The relative nontoxicity, short half life, and high γ energy of ^{113m}In make it potentially the ideal substance to use in clinical investigations. A potential advantage of ^{113m}In is that the patient can be scanned immediately after injection of the isotope in contrast with the delay of 3 to 4 hr that must elapse with ^{197}Hg and ^{203}Hg, and the examination can be completed more quickly. In terms of neurosurgical management, this advantage raises brainscanning to the status and value of an emergency procedure. The so-called halo effect is less marked with ^{113m}In than with ^{99m}Tc. In this respect, ^{113m}In appears to lie between ^{99m}Tc and ^{197}Hg, and since it is rapidly cleared from the blood stream a delay of 30 min after injection abolishes the halo effect still further. (BBB)

871 RADIOISOTOPE PHOTOSCANNING OF THE SALIVARY GLANDS. Razzak, Muhammad A.; Sodee, D. Bruce (Doctors Hospital, Cleveland). Amer. J. Gastroenterol., 49: 503-5(June 1968).

Injected $^{99m}TcO_4^-$ was used for radioisotope scanning of the salivary glands in order to diagnose a patient with a mass in front of the right ear. The scan revealed a space-occupying lesion in the upper and anterior parts of the parotid gland. Following removal by surgery, a benign tumor of the parotid gland was proven. The in vivo count rate over the parotid gland from $^{99m}TcO_4^-$ follows that of the thyroid. The thyroid uptake of this material after 1 hr

amounts to from 3 to 4% of the administered dose. In mice 1.42%/g of the administered dose localizes in the salivary glands by 30 min after subcutaneous injection of $^{99m}TcO_4^-$. Pertechnetate-^{99m}Tc can be used as a scanning agent for the salivary glands to evaluate the function of these glands and to study their morphology. (BBB)

872 THOROTRASTOSIS. Buschmann, O.; Huenig, R. (Zentralroentgeninstitut, Bremen). Med. Klin. (Munich), 61: 14-18(Jan. 7, 1966). (In German).

The roentgenological characteristics of thorotrastosis include increased granulated, shadow densities in liver and spleen, with a reticular aspect frequently in the liver, failure to visualize the liver and spleen capsules, increased liver size and decreased spleen size, and significant dense shadowing in the regions of the lymphatic vessels and nodes, particularly in the area of the hyla of the liver and spleen. Differential x-ray diagnosis of thorotrastosis in 4 patients is described, and the resulting findings of 4 localized thorotrastomas, 2 anemias, 3 cases of liver malfunction, and a liver hemangiosarcoma are discussed. The evidence for thorotrastgranuloma and thorotrastomas, bone marrow injuries, liver and spleen damage are presented. The sequence of induction of Thorotrast tumors and their frequency of occurrence are discussed on the basis of numerous cases reported. (BBB)

873 CLINICAL USE OF RADIOACTIVE ISOTOPES IN ORTHOPEDICS. Bauer, G. C. H. (Cornell Univ., Ithaca, N. Y.). Cornell Vet., 58: Suppl., 149-75(Jan. 1968).

The use of ^{85}Sr for studies of Sr (i.e., Ca) distribution in the knee joint by external counting to provide diagnosis of osteoarthritis of various types, rheumatoid arthritis, aseptic necrosis of the medial femoral condyle, stress fracture of the tibia, and Paget's disease of the femur is described. The two main reasons given for use of ^{85}Sr instead of ^{47}Ca in these studies are that ^{85}Sr has a longer shelf-life, so that it is more readily available, and also ^{85}Sr has a somewhat softer γ radiation, permitting better resolution in counting. Use of ^{85}Sr permits bone metastases to be detected even when roentgenography does not give any evidence of them. An intravenous injection of 0.5 μCi/body wt is acceptable clinically without excessive irradiation doses to the patient. (BBB)

874 DRUG SHIELDS KIDNEY FROM RADIATION. J. Amer. Med. Ass., 206: 753(Oct. 21, 1968).

A series of infusions of epinephrine into the left renal artery were given to a patient with ovarian carcinoma. Eight months after completion of a series of radiation treatments, intravenous pyelograms suggested that the patient's left kidney was functioning better than the right one. Irradiated dogs given epinephrine into the superior mesenteric artery lived six to eight weeks; nontreated controls died within four to eight days. Other experiments with dogs showed that epinephrine did not have a protective effect following irradiation of the small intestine. (H.L.W.)

875 THE LET DISTRIBUTION OF THE RECOIL PROTON DOSE FROM POLY-ENERGETIC NEUTRON SOURCES. Lawson, R. C. (Western Regional Hospital Board, Glasgow); Watt, D. E. Phys. Med. Biol., 13: 619-26(Oct. 1968).

Previous investigations on the linear energy transfer (LET) distribution of the recoil proton dose from monoenergetic neutron sources were extended to include cyclotron produced neutrons and Pu–Be neutrons as examples of poly-energetic sources. The recoil proton absorbed dose, measured at depth in a tissue-equivalent phantom using a Bragg–Gray type detector, is expressed as a function of the LET and is compared with the distributions predicted by theory. Excellent agreement is found between the experimental and theoretical curves. (auth) (UK)

876 APPLICATION OF RADIOBIOLOGIC PRINCIPLES TO RADIATION THERAPY. Suit, Herman D. (Univ. of Texas, Austin). Cancer, 22: 809-15(Oct. 1968).

Oxygen remains one of the most potent sensitizers of mammalian cells yet studied and, most important, it is maximumly sensitizing at physiologic concentrations. There is very good evidence that solid tumors of both experimental animals and man contain hypoxic and viable cells. In experimental animals hyperbaric oxygen does result in improvement of radiation therapy even when the treatment is highly fractionated and protracted over periods of up to 3 to 4½ weeks. This represents strong evidence that—at least in some human tumors—results of fractionated irradiation will be significantly improved by the addition of hyperbaric oxygen. At the same time it is admitted that results of clinical trials of hyperbaric oxygen and radiation therapy do not indicate any marked improvement by the addition of hyperbaric oxygen. However, the trials are early and based on small numbers; they may well show a modest but clinically important improvement as they mature. It is essential that the trials cover several tumor types. Hyperbaric oxygen may not be useful in radiotherapy for all tumors. Evidence from the tests of tourniquet hypoxia and radiotherapy indicate that, at least for osteosarcoma, the hypoxic cell per se may not be the dominant factor in deciding results of standard fractionated therapy. (auth)

877 ENDOLYMPHATIC RADIOTHERAPY IN MALIGNANT LYMPHOMAS. A CLINICAL EVALUATION OF 285 PATIENTS. Bonadonna, Gianni; Chiappa, Sergio; Musumeci, Renato; Uslenghi, Carlo (Univ. of Milan). Cancer, 22: 885-98(Oct. 1968).

Treatment of inguinal and retroperitoneal lymph nodes of 285 malignant lymphomas (143 Hodgkin's disease and 142 lymphoreticular sarcomas) with Lipiodol Fluide ^{131}I (endolymphatic radiotherapy) are reported. From 1961 to 1966 the radioactive contrast material was injected in doses ranging from 0.2 to 2.5 mCi/cc (10 cc each foot). Adequately opacified nodes responded promptly with marked and progressive reduction in size. When indicated, a second administration of Lipiodol ^{131}I in a dose of 2.5 mCi/cc was always feasible. Several factors prevented a homogeneous and satisfactory distribution of radioactive contrast material throughout the iliac and the para-aortic nodes in one-third of the cases. Therefore, in many instances patients had to be treated with external radiation therapy. Histopathologic examination of lymph nodes removed at exploratory laparotomy (four cases) or at autopsy (ten cases) confirmed that Lipiodol ^{131}I did not fill all the iliac and para-aortic nodes and that destruction of lymphomatous tissue was often incomplete. Recurrences were seen mostly in abnormal, adequately filled nodes opacified with high doses of Lipiodol ^{131}I. In Hodgkin's disease they occurred particularly in the para-aortic area and in lymphoreticular sarcomas in the inguinal and iliac chains. Side effects were minimal. They included amenorrhea, pulmonary insufficiency, hepatic failure, and hemolytic anemia. Clinical and histologic signs of pulmonary and hepatic fibrosis were not seen. The authors conclude that endolymphatic radiotherapy should not be considered as a radical treatment for retroperitoneal adenopathies in malignant lymphomas and that its role as a prophylactic therapeutic tool deserves more extensive long-term studies. (auth)

878 CLINICAL PROSPECTS OF IMPROVEMENTS IN RADIOTHERAPY. Chu, Florence C. H. (Memorial Hospital, New York. James Ewing Hospital, New York). Cancer, 22: 796-801(Oct. 1968).

Further radiotherapy can expect improved clinical results with an integrated approach to cancer, with better application of radiotherapy based on radiobiologic principles, and with further developments in diagnostic procedures, physics and general technology. Our past progress has provided us with a clinical basis upon which future developments can grow to achieve the maximum control of cancer. (auth)

879 RESULTS OF HORMONE TREATMENT OF BREAST CANCER, WITH SPECIAL ATTENTION TO PROPHYLACTIC THERAPY. Schmidt, Hermann; Bauer, Robert (Univ., Tuebingen, Ger.). Strahlentherapie, 136: 259-62(Sept. 1968). (In German).

The results obtained between 1949 and 1961 at the radiation center of the University of Tübingen, with a complementary hormonal therapy in 357 patients with breast carcinoma are given. Compared to a group of 366 patients treated without hormonal therapy the results at 5 years are considerably lower, but this group had more extensive lesions. In spite of this disadvantage, the results of hormonotherapy seem better in stage II whatever the overall treatment method is. A statistical significance was not obtained, but these results do not justify abandonment of hormonal therapy, especially in stage II. (auth)

880 VULVAR CARCINOMA AND ITS TREATMENT: A SURVEY OF THE YEARS 1952 TO 1962. Weghaupt, Karl (Univ., Vienna). Strahlentherapie, 136: 270-8(Sept. 1968). (In German).

The different treatment modalities for vulvar carcinoma are outlined, and a survey of published results is presented. At the First Gynecology Clinic of the University of Vienna, 152 patients with vulvar carcinoma were admitted and treated. The therapy was first a coagulation of the primary tumor followed if necessary by a surgical dissection of the groin. For the more extended cases also an electro-coagulation is indicated. A local healing is obtained in this way in 97% of the cases. The inguinal dissection was progressively replaced by an intensive x or telecobalt irradiation. Of the 152 cases, 86 or 56.6% presented palpable nodes. 69.7% were aged between 70 and 100 years. The relation between kraurosis vulvae, present in 80 or 52.6% of the cases is discussed. The relation with menarche and menopause is also discussed: 100 patients or 65.8% had later onset of the menarche than normal. Of the 152 cases, 79 or 52% were cured at 5 years or more. The primary mortality was 1.3% (2 cases). 16 patients died of intercurrent diseases. In 19 patients diabetes mellitus was present. (auth)

881 METHODS AND RESULTS OF TREATMENT OF CERVICAL CARCINOMA (1954 TO 1964). Kahr, Ernst; Schreyer,

Herbert (Univ., Graz). Strahlentherapie, 136: 263-9(Sept. 1968). (In German).

The results and the experience with primary, pre- or post-operative irradiation in 351 patients with cancer of the uterine cervix (1954 to 1964) are presented. (auth)

882 BALNEOTHERAPY OF RADIATION INJURIES. PART 17. RESULTS IN THE RESEARCH INSTITUTE OF ATOMIC BOMB SURVIVORS' UTILIZATION OF BEPPU HOT SPRING. Hatta, Osamu (Kyushu Univ., Japan). Oita Ken Onsen Chosa Hokoku Syo, No. 16, 1-3(Mar. 1965). (In Japanese).

The spa treatment of atomic bomb survivors at Beppu Hot Spring for one year from April, 1964, to March, 1965, was studied. The results obtained are as follows: The total number of hot spring users is 1672, 37.4 a day. The numbers in April and May are larger than in the other months, 48.9 and 45.3 per day respectively. Women use the spring more than men. As to the number of staying days, 7 to 13 days are the most, one third of the whole using the spring this way. Of 911 users who stayed about 14 days, 98 persons whose atomic-bomb exposure states are relatively well-known were selected, and their blood properties, blood pressure and urine, before and after the spa treatment, were examined. In many atomic bomb survivors the leucopenia and the abnormality of the maximum blood pressure are often observed, but by the spa treatment, the leucopenia was found to have been remarkably improved. (NSA of Japan)

883 REALISTIC TREATMENT PLANNING. Laughlin, John S. (Memorial Hospital for Cancer and Allied Diseases, New York. Sloan-Kettering Inst. for Cancer Research, New York). Cancer, 22: 716-29(Oct. 1968).

Some ionizing radiations in specified energy ranges have physical properties which make them useful in treating human cancers, although this method of treatment has limitations. Limitations which make radiation therapy difficult as compared with such methods as surgery are described. The advantages and problems of the application of high-energy x-rays and electron sources are discussed. The author discusses specialized instruments and techniques developed for use in modern radiation therapy. The application of these techniques has required the development of systems for comprehensive treatment planning to be made available to many patients. (auth)

884 TECHNIQUES FOR TUMOR LOCALIZATION. Lingren, Martin (University Hospital, Lund, Sweden). Cancer, 22: 735-44(Oct. 1968).

Modern radiotherapy requires reliable knowledge of the site of the tumor, of its extent and of its relation to adjacent tissues and organs. It is sometimes difficult to obtain such information on deep-seated tumors. This implies a risk of inadequate dosage. Various techniques are available for locating tumors, viz., angiography, lymphography, hysterography and various scanning methods. Examples of the value of each technique in demonstrating the site and extent of tumors are given. (auth)

885 TECHNIQUES OF INTERSTITIAL AND INTRACAVITARY RADIATION. Hilaris, Basil S. (Memorial Hospital, New York). Cancer, 22: 745-51(Oct. 1968).

With interstitial implantation and intracavitary applications a much higher dose can be delivered to the tumor than possible with external radiation. At the same time, a much lower dose is given to the adjoining normal tissue. The high doses delivered with internal radiation are tolerated well because the irradiated volumes are very small compared to the volumes which are irradiated with external radiation therapy even with small-field technique. Methods and radioisotopes commonly used for this purpose are complicated and unsatisfactory from the radiation safety point of view. For this reason, new methods with artificial radioisotopes were developed at Memorial Hospital. Included are the remote afterloader with which all intracavitary applications were carried out since July, 1967, and the use of low energy ^{125}I seeds for interstitial implants. Clinical experience with both techniques indicates that most of the drawbacks of the older methods are eliminated while their proven therapeutic value is retained. (auth)

886 CURATIVE RADIOTHERAPY IN THE MALIGNANT LYMPHOMAS. Nobler, Myron P. (Memorial Hospital, New York). Cancer, 22: 752-8(Oct. 1968).

The clinical experience and technologic improvements of the past 40 years are briefly summarized in terms of their contributions to the present optimistic and aggresive approach to the treatment of malignant lymphoma. The reasoning behind the large-field, moderately high-dose technique that has evolved is reviewed and analyzed, and our treatment techniques are described in detail. Finally, the curability of malignant lymphoma is emphasized—through the use of vigorous and precisely planned irradiation of both the actual and the potential sites of lymph node involvement in either the upper or the lower trunk regions, or, in some cases, in both regions, we may now hope to produce cures or long-term survivals in a great majority of the patients treated; this results in a magnificent gain for humanity through the rescue or prolongation of many otherwise lost lives. (auth)

887 BALNEOTHERAPY OF RADIATION INJURIES. RESULTS OF THE RESEARCH INSTITUTE FOR UTILIZATION OF BEPPU-HOT SPRING BY A-BOMB SURVIVORS. Hatta, Osamu (Kyushu Univ., Japan). Oita Ken Onsen Chosa Hokoku Syo, No. 17, 32-6(Mar. 1966). (In Japanese).

A study was made on the results of hot-spring cure of A-bomb survivors at the Beppu hot-spring for the period of April 1965 to March 1966. The results obtained are as follows: The total number of utilizers was 1646. Many were in April, January, and February, and a few in July, October, and December. More women than men used the hot springs. About 40% of the people stayed 7 to 13 days. Peripheral blood, maximal blood pressure, and urine were examined before and after the hot-spring cure in 75 of 846 persons who stayed about 2 weeks. The leukocyte count and maximal blood pressure were abnormal in many cases. The 31 cases (41.3%) of abnormality of leukocyte count observed before bathing were reduced to 12 cases (16.0%) after hot-spring cure: while 23 cases (30.6%) of the former were reduced to 15 cases (20.0%) after hot-spring cure. Two cases of oligocythemia and 1 case of oligochromemia did not recover after treatment, but their erythrocyte count and hemoglobin amount were restored near to the normal value. Two cases having glycosuria did not show any improvement after treatment. The abnormality in aldehyde test of urine observed in 10 cases before bathing was also found in 9 cases after treatment. Nine A-bomb survivors in Oita Prefecture were subjected to 2 weeks' hot-spring cure; and nearly the same results as above were obtained. The function of pituitary-adrenal system, examined by Thorn's test, was not clearly improved. (NSA of Japan)

888 BALNEOTHERAPY OF RADIATION INJURIES. PART 18. EFFECT ON RADIATION INJURIES OF TAKING A BATH ADDED WITH THE INCRUSTATIONS OF HOT SPRING. Hatta, Osamu; Yamada, Tomiko (Kyushu Univ., Japan). Oita Ken Onsen Chosa Hokoku Syo, No. 16, 4-9(Mar. 1965). (In Japanese).

In the spring season, mature rabbits were subjected to 510 R of whole-body γ irradiation with ^{137}Cs, and then were treated with various hot springs or administered cysteamine (40 mg/kg × 7 times). And the effects of these treatments on the loss of body weight, decrease of the serum thiol value and of nucleated bone marrow cells were examined. The results obtained are as follows: In the groups subjected to spa treatment with hot spring at the Atomic Bomb Center, or the hot spring plus incrustations of hot spring, as well as in the group administered cysteamine, remarkable restorative effects on the γ-ray injuries were observed. The principal difference between the springtime and previous autumntime experiments is that the number of nucleated bone marrow cells is larger and the serum thiol value is lower in the springtime. The regain of body weight, observed on and after 10 days, is remarkable in the cysteamine group and the group taking a hot spring plus incrustations of hot spring. The γ-radioinduced decrease of nucleated bone marrow cells in rabbits is not restored two weeks after exposure by hot-spring baths. In the springtime, the decrease of serum thiol value by γ-ray irradiation is considerable, but its restoration 2 weeks after irradiation is remarkable in the groups taking a hot spring bath. In the experiments of the springtime and autumntime, the results in the group taking a hot-spring bath plus incrustations of hot spring are superior to those in the group treated by the hot spring at the Research Institute of Hot Spring, and therefore it seems certain that the addition of incrustations of hot spring increases the restorative effect on the radiation injuries to some extent. (NSA of Japan)

889 PRELIMINARY REPORT ON THE USE OF ^{32}P COMPRESS IN THE TREATMENT OF NEURODERMATITIS. Chiang, Po-ya (Shantung Medical Coll. Hospital, China). Shan Tung I K'an, No. 8, 10-11(Aug. 1964). (In Chinese).

Although neurodermatitis is a common skin disease, treatment has been less than satisfactory. The results of radioisotope P-32 compress treatment in 58 patients with this disease are presented. The energy characteristics of this isotope are described and its method of application indicated. The results are superior to those obtained from other forms of therapy on a short term basis. Long-term prognosis must remain guarded. This and the selection of optimum dosage should receive further investigation. (JPRS)

890 PRELIMINARY OBSERVATIONS OF RADIOISOTOPE ^{131}I IN THE TREATMENT OF HYPERTHYROIDISM. Chang, Mao-hung; Li, Jen-cheng (Shantung Medical Coll. Hospital, China). Shan Tung I K'an, No. 8, 3-5(Aug. 1964). (In Chinese).

Results of ^{131}I treatment in 32 patients show significant thera-

peutic effect in 18.5% and no improvement in 18.5% of cases. Thyroid crises were induced in 2 patients and transient myxedema in one. Those with favorable response show improvement in clinical course within one week, and recovery in 2-3 months after onset of treatment. Increase in body weight is the most sensitive index of therapeutic response, followed by loss of tremor and cardiac arrhythmia, and finally by the return to normal of the laboratory tests. The importance of precise estimation of the thyroid mass in the therapeutic outcome is emphasized. (JPRS)

891 DIAGNOSIS AND CONTROL OF SKELETAL METASTASES OF MAMMARY CARCINOMA USING ^{85}Sr. Kolar, Jaromir; Bek, Vaclav; Janko, Ladislav; Babicky, Arnost; Vyhnanek, Lubos (Univ., Prague). Strahlentherapie, 136: 289-300(Sept. 1968). (In German).

The authors report their experience with the ^{85}Sr test in 124 patients with mammary carcinoma, suspected of having skeletal involvement. These patients are part of a group of 403 patients to whom the test was applied. The aspecificity of the test is stressed. The principal advantage of this method is the possibility of discovering precociously small skeletal lesions. The diagnosis of the nature of the lesion, however, is not possible. The advantage of making a measurement at the first and the 7th day, and calculation of an index, is outlined. This should permit earlier diagnosis. As sources of errors in patients with malignant diseases, all other pathologic bone conditions should be taken into account. Finally the several factors influencing the skeletal uptake of this isotope are discussed. Control measurements are recommended during therapy, but their results should be critically studied, taking into account results of subsequent studies. (auth)

892 STUDIES OF X-RAY PROTECTIVE AND X-RAY THERAPEUTIC ACTION OF HYDROLYZATES FROM RED BONE MARROW. Kolev, D.; Manolov, P.; Tsochev, Ts.; Koleva, M.; Zarkova, S. (Higher Medical Inst., Sofia). Eksp. Med. Morfol., 6: 257-9(1967). (In Bulgarian).

The hemostimulating action of red bone marrow produced by acid hydrolysis following x irradiation was reported. The stimulating activity of three kinds of hydrolyzates (enzymic, acid, and alkaline) obtained from calf red bone marrow after x-ray and benzene damage of hematopoiesis was tested. No positive x-ray therapeutic effects were found after administration of these hydrolyzates. Following a prophylactic application of acid hydrolyzate there was some prolongation of the life of the irradiated animals as well as an earlier recovery of hematopoiesis. (JPRS)

893 RECURRENT CANCER OF THE CERVIX UTERI. Graham, John; Graham, Ruth; Hirabayashi, Koji (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 126: 799-804 (Apr. 1968).

Enhancement of the effect of radiotherapy by treatment with vaccines and sulfone drugs in patients with recurrent cervical cancer is reported. Encouraging preliminary results were obtained by injection of pertussis vaccine into the tumor prior to radiotherapy, and administration of dapsone orally before, during, and after radiotherapy. It was found that a high concentration of mast cells about the tumor in a primary cancer of the cervix gave a good prognosis and few mast cells a bad prognosis. Pertussis vaccine was a potent elicitor of mast cell lysing antibody. It was injected into the tumor of seven patients in the hope of priming the tissues for a better response to subsequent radiotherapy. Four patients lived more than a year. This survival was better than expected. Dapsone, given before, during, and after radiotherapy appeared to have a beneficial effect. Three of 11 previously treated with radiation were living and well more than six years later. None of eight who underwent previous surgical intervention survived for even a year. The results of dapsone plus radiotherapy after previous radiotherapy were remarkable. (BBB)

894 INDICATIONS OF TELECESIUM THERAPY IN CARCINOLOGY. Amalric, R.; Clement, R.; Santamaria, F.; Robert, F.; Spitalier, J. M. (Univ., Marseille). Presse Med., 75: 1947-50(Sept. 23, 1967). (In French).

Dose calculations, isodose charts, and clinical results and complications were reported for a large series of patients treated by radiocesium therapy. Out of 2300 cancer cases irradiated with ^{137}Cs, the best results were obtained in three areas: mammary cancer, advanced skin cancer, and malignant tumors in the oral-nasal-laryngeal area. Doses used in postoperative therapy of mammary cancer ranged from 5000 to 8000 rad over a period of 10 to 12 weeks. In skin cancer cases, the ideal dose was found to be 7000 rad in six weeks, using a shorter focal distance for the radiation. Doses for oral tumor ranged from 7000 to 9000 R over seven to seven and a half weeks. Advantages of ^{137}Cs therapy were discussed, especially the fact that all of the dose was accumulated in 1.2 mm depth of the skin, rather than 6 mm as for ^{60}Co. This aids in protection against deep radiation injury. The dose was considerably greater at 5 cm focal distance than with other methods. Beyond 5 cm, the effect of ^{137}Cs decreases rapidly as compared with ^{60}Co. General tolerance and, specifically, hematologic tolerance was increased in relation to x-ray treatment because the integral dose was less, while the risk of chondro- and osteo-necrosis is greatly reduced by absorption of radiation from ^{137}Cs by the overlying tissues. It was concluded that ^{137}Cs as an intermediate range treatment between conventional radiotherapy and telecobalt therapy, was particularly well adapted to areas from 1 mm to 5 cm in depth under the skin, the range of γ radiation from ^{137}Cs. (BBB)

895 RESULTS OF THE USE OF SYNTHETIC ANTIMALARIALS IN THE TREATMENT OF SCLEROSIS FOLLOWING RADIOTHERAPY. Chemama, R.; Ennuyer, A.; Bataini, P. (Foundation Curie, Paris). Sem. Hop. Paris, 43: 592-7(Feb. 20, 1967). (In French).

A comparison was made between side-reactions to transcutaneous radiotherapy due to high-energy γ radiation and reactions following applications of 200-KV x-ray therapy. Severe reactions, such as intense erythema and exsudative epidermitis, frequently occur after conventional x-ray therapy. After radiocobalt therapy, skin reactions, even early ones, are milder and mainly limited to increased pigmentation. The reasons for this are discussed, especially the fact that the radiation dose from 200-KV x rays is greatest at the skin level, whereas radiocobalt produces a maximum dose at 4 to 5 mm below the surface. However, late reactions to telecobalt therapy are significant below the skin, especially in short-term treatments; very severe reactions may occur in small areas. A new method was evolved for treating radioinduced sclerosis with antimalarials. A group of 47 patients treated for cancer was studied, 25 of which had been treated by radiocobalt therapy, seven by x-ray therapy at 200 or 250 KV, two by the betatron beam, and 13 by a combination of two or three methods of irradiation. In 19 cases surgery had aggravated sclerosis. Radiation injury was first observed at the following times: at the first clinical checkup in 24 cases, from one to six months later in six cases, from seven to 12 months later in three cases, from 13 to 24 months later in six cases, and after 25 months or more, in eight cases. After treatment with antimalarials, over 55% of the cases showed improvement. (BBB)

896 RADIATION THYROIDITIS AS A COMPLICATION OF TREATMENT WITH RADIOIODINE. Hoeschl, R.; Nemec, J.; Silink, K.; Kubal, J. (Vyzkumny Ustav Endokrinologicky, Prague). Cas. Lek. Cesk., 105: 511-14(May 13, 1966). (In Czech).

In 321 patients treated with 357 doses of radioiodine for hyperthyroidism or for cancer of the thyroid gland, the development of radioinduced thyroiditis (RIT) and acute edema of the soft tissues followed. Radiation thyroiditis was established in 44.7% of the patients with cancer of the thyroid gland. The frequency increased in proportion to the dose. Most often RIT appeared on the third to fifth day. With higher doses the onset was earlier; however, RIT may develop even as late as three weeks following ^{131}I administration. It lasts on an average of ten days. Also studied was the relation between RIT and the shortening of the effective biological half-time of radioiodine. The duration of RIT could not be influenced by corticosteroid treatment. Perithyroidal edema, developing during the first 48 hr following administration of higher doses of radioiodine, was observed in 13% of the cases treated for malignancy. (BBB)

Radiation Effects on Animals

Refer also to abstracts 777, 804, and 1728.

Invertebrates

Refer also to abstracts 773, 784, and 799.

897 (ORO-1749-19) STUDY OF THE EFFECTS OF RADIATION ON HOST-PARASITE RELATIONSHIPS. Progress Report. Jones, Arthur W. (Tennessee Univ., Knoxville. Dept. of Zoology and Entomology). June 15, 1968. Contract AT(40-1)-1749. 9p. Dep. CFSTI.

Larvae of the beetle, Tribolium confusum, were infected with the cestode, Hymenolepis microstoma, and it was found that infection rates were related to size of beetles when fed, that infection retarded growth and development of the host, and that metamorphosis of the host did not have any effect on the number of established cysticercoids. Experiments on selfing of the cestodes indicated that there was no diminution of fertility, infectivity, or

size. Other studies were conducted on chromosome analyses, mitotic rhythm, fecundity, and growth patterns. Immunological studies included in vivo and in vitro effects of yomesan and determination of duration of immunity of the mouse to Hymenolepis microstoma. Experiments on differential effects of radiation on early growth stages of adult cestodes showed that response to x rays increased during the first six days after establishment in the mouse and that particular anomalies showed distinct patterns based on age at irradiation. Radiation mimicry by EMS was observed as a high frequency of anomalies in some of the worms. Radioprotective effects of AET and nitrogen were demonstrated. (H.L.W.)

898 AGE-DEPENDENT RADIOSENSITIVITY IN ADULT SARCOPHAGA PEREGRINA. sakka, Masatoshi (Tohoku Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 569-72(Aug. 1968). (In Japanese).

Adult Sarcophaga peregrina were irradiated at day 1 of imago life with different doses of x rays. Mean survival time decreased exponentially with dose in both sexes in the range from 0 to 160 kR. When a single dose of 40 kR was given to adults at different ages, the loss of survival time was greater when they were irradiated younger, the loss as a percentage of control life span was minimal when a population lost one quarter of the life span. The shortening of life was explained by the upward shift of age specific mortality rate. (NSA of Japan) (auth)

899 CELL DIVISION: COMBINED ANTI-MITOTIC EFFECTS OF COLCHICINE AND HEAVY WATER ON FIRST CLEAVAGE IN THE EGGS OF ARBACIA PUNCTULATA. Marsland, D.; Hecht, R. (New York Univ., N. Y. Marine Biological Lab., Woods Hole, Mass.). Exp. Cell Res., 51: 602-8(Aug.-Sept. 1968).

The anti-mitotic effects of colchicine and of heavy water, used separately and in combination, were studied with reference to inhibition of first cleavage in the eggs of Arbacia punctulata. Treatments were initiated at early prophase which at the experimental temperature (20 + 0.1°C) was 17 min before the first appearance of cleavage furrows. With lower concentrations of D_2O (25 to 35%) the two anti-mitotic agents antagonized each other over the whole range of colchicine concentrations (3.0 to 8.5×10^{-4} M). At higher concentrations (55 to 65% D_2O) there was a distinct synergism throughout; whereas, at intermediate D_2O concentration (45%) synergism was observed when the colchicine concentration was below 6.0×10^{-4} M and antagonism when the colchicine concentration was above this point. A tentative interpretation, in terms of molecular mechanisms, is proposed. (auth)

900 SOME EFFECTS OF GAMMA RADIATION ON THE TOBACCO BUDWORM, HELIOTHIS VIRESCENS (FABRICIUS). El-Sayed, El-Sayed Ibrahim. Baton Rouge, La., Louisiana State Univ. Baton Rouge, La., Agricultural and Mechanical Coll., 1968. 79p.

Thesis.

Some effects of γ radiation on the 4 developmental stages of the tobacco budworm, Heliothis virescens (Fabricius) were studied. Resistance to the lethal effects of γ irradiation increased as development of the insect progressed from the egg through the adult stage. Exposure of 1-day-old larvae to 7,000 rads resulted in 98.4% mortality. In contrast, exposure of 0- to 1-day-old adults to 222,007 rads resulted in 93.5 and 95.2% mortality after 72 hours in males and females, respectively. Dosages of γ irradiation applied to pupae that effected a high level of sterility in resulting moths also caused considerable mortality, especially in young pupae. In addition to mortality, deleterious effects on oviposition, mating frequency, and mating competitiveness seemed apparent. Complete sterility was induced when adults were exposed to 40,000 rads of γ irradiation. Deleterious effects on adults exposed to this dosage were greatly reduced in comparison to pupae. Oviposition of treated females and mating frequency of treated males appeared to be affected. However, irradiated (30,000 rads) males competed equally with normal males when males were confined with virgin females at 1:1:1 ratio. Irradiation of pupae or adults resulted in considerable mortality of their progeny. For example, 15.4% of the eggs produced by crossing irradiated 0- to 1-day-old male and female moths (10,000 rads) were observed to hatch. However, only 16% of these larvae completed their life cycle and emerged as normal-appearing adults. Female reproductive tissue appeared to be more radiosensitive in both the pupal and adult stages than male reproductive tissue. (Disser. Abstr.)

Vertebrates

Refer also to abstracts 779, 781, 783, 785, 786, 797, 805, 806, 808, 814, 851, 853–856, 874, 892, and 957.

901 (CEA-R-3396) EVOLUTION OF GLYCEMIA DURING IRRADIATION SYNDROME. Raisonnier, Alain (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1968. 39p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

The evolution of glycemia following cobalt-60 γ irradiation has been followed in the rat and pig. The results concerning a case of human accidental exposure have also been included. An attempt was made to see whether the observed variations are reproducible and have a prognostic value. (auth)

902 (CEA-R-3409) INFLUENCE OF BIOLOGICAL AND ECOLOGICAL FACTORS ON THE RADIO-SENSITIVITY OF LABORATORY ANIMALS. Guenet, Jean-Louis; Legeay, Gerard (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1968. 35p. (In French). Dep.

The biological and ecological factors liable to induce a change in the radiosensitivity of a species are undoubtedly responsible for the large fluctuations observed during radio-biological experiments. It is easy to limit or to suppress the effects of some of them (genetic or nutritional factors). Since the research worker cannot control the others it is necessary to take them into account. In this report the authors analyze the action of two factors chosen as examples, biological rhythms, and the role of health conditions. Other factors will be dealt with in a later report. (auth)

903 (CEA-R-3447) RELATIVE BIOLOGICAL EFFICIENCY OF 592 MeV PROTONS. ANALYSIS OF THE BIOLOGICAL EFFECT OF SECONDARY RADIATION. Legeay, Gerard; Baarli, Johan (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires. European Organization for Nuclear Research, Geneva (Switzerland)). June 1968. 43p. (In French). Dep.

The relative biological efficiency (RBE) of high energy protons is of importance because of their effects in the field of radioprotection around large accelerators and during space-flights. The nature of the interactions between 592 MeV protons and biological tissues makes it necessary to take into consideration the contribution of secondary radiation to the biological effect. Since it is not possible to obtain from a synchrotron a beam having a sufficiently large cross-section to irradiate large animals, one has to resort to certain devices concerning the mode of exposure when small laboratory animals are used. By irradiating rats individually and in groups, and by using the lethal test as a function of time, the authors show that the value of the RBE is different for animals of the same species having the same biological parameters. Thus there appears an increase in the biological effect due to secondary radiation produced in nuclear cascades which develop in a large volume, for example that of a human being. (auth)

904 (NP-17579, pp III.17-30) RADIOBIOLOGY. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Reduction of short- and long-term lethality in mice by radioprotective compounds was studied. The following compounds were used alone or in mixtures: AET, cysteamine, cysteine, glutathione, and serotonin. Results showed that mixtures increased the degree of protection against x radiation compared with that conferred by each substance given separately. Mixtures of AET, glutathione, and serotonin were used to study protective effects on cell renewal in the duodenum of x-irradiated mice. Effects of x radiation on the ultrastructure of the small intestine of mice were studied. Experiments were conducted on radioinduced chromosome aberrations in mice. The albumin content of various tissues of mice was determined using ^{125}I and ^{131}I. Mitochondria from the liver, kidneys, and heart of normal and x-irradiated rats were studied. Experiments on rats and mice showed that breakdown of DNA accounted for most of the deoxycytidine in urine following irradiation. Effects of radiation on metabolism of nicotinic acid, nicotinamide coenzymes, and tryptophan were studied. The ratios between levels of ^{85}Sr and ^{226}Ra in grass and milk were determined. The relationship between yield of pasture and levels of ^{134}Cs and ^{85}Sr in grass and milk was studied. Studies were conducted on effects of ionizing radiation on chlorophyll accumulation in the leaves of green plants. Effects of actinomycin D on DNA and RNA metabolism in Arabidopsis thaliana were studied. Microscopic and chromatographic studies were conducted on the wood of Larix decidua and Betula verrucosa destroyed by fungi. Localization of ^{35}S in the leaves of green plants was determined using autoradiographic techniques. Effects of γ radiation on morphogenesis and nucleic acid synthesis in the alga, Acetabularia mediterranea, were studied. Root patterns of the desert shrub, Sarcobatus vermiculatus, were studied using ^{22}Na and tritium-labeled-water. Other studies included: mineral metabolism in animals; activity of nucleoside kinases, mechanism of action of sulfhydryl radioprotectors; intracellular distribution of thymidine kinase; liver polysomes; effects of IAA and of γ radiation

on nucleic acids and protein synthesis in pea roots; preparation of artificial nucleoproteins; chromatography of soluble and ribosomal RNA; DNA of germinating barley and tomatoes; fate of DNA injected into mice; absorption of macromolecules by cells in tissue culture; influence of AET on metabolism of HeLa cells; effects of DNA on irradiated chick embryos; radiolesions of germ cells after incorporating ^{3}H-thymidine in embryonic tissues; and ^{3}H-uridine incorporation during vitellogenesis in oocytes of the chick. (H.L.W.)

905 HEMATOLOGICAL RECOVERY IN THE MOUSE FOLLOWING SINGLE DOSES OF GAMMA RADIATION AND CYCLOPHOSPHAMIDE. Valeriote, Frederick A.; Collins, David C.; Bruce, W. Robert (Univ. of Toronto). Radiat. Res., 33: 501-11(1968).

The number of platelets, reticulocytes, erythrocytes, peroxidase-positive cells, and leukocytes in the peripheral blood was determined following the administration of single doses of either 300 and 500 RADS of γ radiation or 3 and 5 mg of cyclophosphamide to the mouse. At the same time, the number of colony-forming units (CFU) in the spleens and femoral marrows of the mice was determined. It was found that the time required for the cells in the peripheral blood and the CFU in the hematopoietic organs to return to their normal levels was prolonged following γ irradiation (14 to 18 days), whereas following cyclophosphamide the time interval was relatively short (5 to 10 days). (auth)

906 ELECTRON MICROSCOPIC STUDIES ON THE ORTHOLOGY AND EXPERIMENTAL PATHOLOGY OF THE CEREBELLUM OF THE MOUSE. Wessel, Wolfgang (Univ., Bonn). Veroeff. Morphol. Pathol., 71: 1-95(1966). (In German).

Morphology of the normal mouse cerebellum at high magnification is described, and pathological changes in the cerebellum in alloxan diabetes, viomycin intoxication, repeated acute oxygen deficiency, and after high-dose x irradiation are reported. Diabetes mellitus causes a severe swelling of the neuroglia and granular cells. The nerve cells, rich in cytoplasmic organelles, especially ribonucleoprotein structures, are not involved. The diabetic type of metabolism leads to an increase of the dark (chromophilic) Purkinje cells. Viomycin in high dosage causes necrosis of the nerve cells in the molecular layer, while changes in the neuroglia are comparatively small. The Purkinje cells show degenerative changes, mainly a loss of RNA and a reduction of the vesicles in the foot processes. Granular cell pyknosis also occurs. Repeated acute oxygen deficiency leads to damage of the nervous elements and the neuroglia. Aside from necrosis of the small ganglion cells, in the Purkinje cells a loss was noted of ribosomes and degenerative changes of the Golgi zone occurred with an increased formation of lipid pigments in the adjacent Bergmann glia. After x irradiation of the brain with 6000 R, within $\frac{1}{2}$ hr swelling of the capillary endothelium occurred and sometimes complete vascular occlusion. One hr following the initial swelling, decomposition of the cells began. While the cells with few cytoplasmic organelles (neuroglia as well as small nerve cells) exhibited hydropic swelling of mitochondria, shrinking of mitochondria was found in the Purkinje cells. The edema of the cerebellum existing during the first hour following irradiation resulted in extracellular fluid accumulation after the breakdown of the cell membranes. Structures longest preserved of the cerebellar cortex were the mossy fiber rosettes of the glomeruli cerebellosi. The functional unit of neuron and adjacent neuroglia was demonstrated by the course of these pathological alterations in the cerebellum. (BBB)

907 SACCHARIN AVERSION BY RATS SUBSEQUENT TO TREATMENT WITH PROFFERIN AND X IRRADIATION. Feinberg, Allen Mark. Tallahassee, Fla., Florida State Univ., 1966. 39p.

Thesis.

Rats' preferences between a saccharin solution and tap water were measured at intervals of 1, 2, 6, 24, 48, 72, and 96 hours following treatments with 68 R x radiation, proferrin, or both proferrin and x radiation. The saccharin preference test was initiated at 0, 12, or 24 hours following the proferrin or x radiation treatments. Both proferrin and x irradiation were observed to lead to avoidance of the saccharin solution. When animals were treated with both proferrin and x irradiation there was greater saccharin avoidance than when the animals received only one of these treatments. Increasing the intervals between the treatments and the saccharin preference test diminished the saccharin avoidance effect. These results support the hypothesis that proferrin and x irradiation effected saccharin preference in a similar manner. (Disser. Abstr.) (TSS)

908 ULTRASTRUCTURAL CHANGES IN LYMPHOCYTES EXPOSED TO NOXIOUS AGENTS IN VITRO. Trowell, O. A. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.). Quart. J. Exp. Physiol., 51: 207-20(July 1966).

The cytopathological changes produced in lymphocytes by x rays and other noxious agents applied in vitro were studied under the electron microscope. Four different lesions were found: (1) the anoxic lesion, produced by anoxia or cyanide, characterized by gross watery swelling of all the cytoplasmic components and internal breakdown of the nucleus; (2) the lesion produced by SH poisons, characterized by swelling of the cytoplasmic matrix and destruction of the cell and nuclear membranes; (3) the lytic lesion, produced by tear gases and chloroform, characterized by rapid onset of cytoplasmic lysis, and (4) the radiomimetic lesion, in which the most striking feature was an increased number of ribosomes. The lesion produced by x rays was very different from the three preceding ones, but was relatively unspecific; exactly the same lesion was produced by most of the slow-acting poisons, and also by glucose deprivation. The earliest radioinduced changes were darkening of the cytoplasm, development of very small membrane-walled vacuoles in the most peripheral part of the cytoplasm, and disappearance of the nuclear envelope. These all appeared at about the same time. The results suggest that radiation, cortisone, mitotic poisons, and barbiturates kill lymphocytes by interfering with the uptake or early metabolism of glucose by the cells. (BBB)

909 COMPARATIVE EFFECTS OF ACTINOMYCIN AND IONIZING RADIATION ON ENZYME SYNTHESIS IN MAMMALIAN CELLS IN VIVO. Pitot, Henry C.; Peraino, Carl; Lamar, Carlos Jr. (Univ. of Wisconsin, Madison, Argonne National Lab., Ill.). Radiat. Res., 33: 599-608(1968).

Studies using actinomycin D or ionizing radiation did much to elucidate our knowledge of the control of genetic expression in mammalian tissues. However, little effort was made to correlate the findings with one inhibitor with those obtained with the other. In the regenerating liver system in rats, DNA synthesis as well as the increase in DNA polymerase resulting from a partial hepatectomy was inhibited by actinomycin and x radiation when the inhibitor was administered within the first 15 hours after the operation or, in the case of radiation, sometime before. If these substances were given after this time, no effect was noted on these processes. Studies on the control of enzyme synthesis in mammalian cells showed that hormonal induction of enzyme synthesis was inhibited by actinomycin, whereas substrate or dietary induction of several enzymes showed different or no effects. The induction of serine dehydrase in rat liver was initially sensitive and later resistant to the effects of actinomycin as well as γ radiation. Tyrosine transaminase induction by cortisone was sensitive to actinomycin but was completely resistant or, in some cases, actually stimulated by ionizing radiation. Insufficient data was available to explain these rather paradoxical effects. It was suggested that the mechanism of action of corticosteroids was not at the level of genetic transcription as previously thought but acted to regulate the rate of enzyme synthesis at the translational level. (auth)

910 A PRELIMINARY STUDY ON THE EFFECT OF COMBINED ACTION OF ULTRA-VIOLET AND INFRARED RAYS ON CHICK EMBRYO AND POST EMBRYONIC GROWTH. Sung, Shang-chih. Ho Pei Ts Hsueh Hsueh Pao Tzu Jan K'o Hsueh Pan, No. 2, 91-7(Jan. 1963). (In Chinese).

In April 1961, on the basis of previous study on the effect of infrared rays on the chick embryo and postembryonic development, the effects of combined action of ultraviolet and infrared rays were studied. By July 1962, the results of four series of experiments were completed. The effects were much more complicated than the single factor of infrared rays. Using the current dosage of combined rays, the effect was primary inhibition with some abnormal embryos and a reduced hatching rate. The incubation period was shortened to 1.5 to 2.5 days, however. Thus, a combined action of these rays may perhaps have promoted the development of the embryos. The chicks that hatched from the four series of experiments grew satisfactorily into adult chickens, and the effects of these rays on the second generation will be studied. (JPRS)

911 THE EFFECT OF PLATED CELL NUMBERS ON THE SURVIVING FRACTION OF X-IRRADIATED HeLa S3 CELLS. Masuda, Kouji (Kyushu Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 28: 579-82(Aug. 1968). (In Japanese).

Using a single cell culture method, the effect of the number of plated cells on the survival of x-irradiated HeLa S3 cells was studied. By increasing the number of plated cells in a petri dish by a factor of three, a two-third reduction in the surviving fraction of cells was achieved at several dose levels. Concerning plating efficiency, no statistically significant decrease in growth was observed with an increase in plated cell numbers. Replacement of growth media seven days postincubation did not alter the decrease in the surviving fraction of groups containing larger numbers of cells. It was therefore concluded that the surviving postirradiation fraction with cell reproductive capacity decreased, not only with

increasing dose, but with increasing cell numbers, as well. (NSA of Japan) (auth)

912 THE INFLUENCE OF PREMEDICATION WITH BARBITURATES ON THE LENGTH OF THIOPENTAL EFFECT ON IRRADIATED RATS. Hudec, A.; Jedlicka, F. Voj. Zdravot. Listy, 36: No. 4, 158-61(Aug. 1967). (In Czech).

Phenobarbitol reduced the length of time for which the thiopental effect lasted in female rats to a greater extent than barbital and amobarbital. Intraperitoneal administration of barbital or subcutaneous administration of phenobarbital reduced the length of time of the thiopental effect not only in healthy animals, but also in irradiated rats that were subjected to radiation doses of 700 or 800 R γ radiation. This effect was observed in the second half of the first week following irradiation. (JPRS)

913 AUTORADIOGRAPHICAL STUDIES ON SPERMATOGENESIS IN THE FISH, ORYZIAS LATIPES, WITH SPECIAL REFERENCE TO RADIATION EFFECTS ON FERTILITY OF FISH. Egami, Nobuo; Hyodo-Taguchi, Yasuko; Konno, Kenjiro (National Inst. of Radiological Sciences, Chiba, Japan). Gunma Symp. Endocrinol., 4: 147-59(1967).

In males of Oryzias latipes x-irradiated at 8 kR, spermatogenic cells in testes underwent complete degeneration within a week. Irradiation of the whole body or the testicular region only of the body with 2 kR resulted in a temporary reduction in testicular weight and fertility during a period ranging from 2 to 6 weeks. Autoradiographs of testes of non-irradiated fish injected with ^{3}H-thymidine revealed that ^{3}H-thymidine was incorporated into spermatogonia and spermatocytes at the early leptotene stage and that the labeled spermatocytes became spermatozoa after finishing normal meiosis in about 12 days or more at 25°C. Autoradiographs of testes of fish exposed to 2 kR of x rays showed that the irradiation inhibited further development of a greater part of actively dividing spermatogonia and spermatocytes at the earliest stage of meiotic prophase, while dormant spermatogonia, spermatocytes at later stages of meiosis, spermatids and spermatozoa were left unaffected. As a consequence, a marked decrease in the number of spermatozoa resulting in a temporary loss of fecundity took place in the males within a few weeks after irradiation. From the data of the present and previous experiments with embryos and adults of Oryzias, it was concluded that radioinduced sterility in embryos and adult males was mainly due to the inhibition of proliferation of germ cells at radiosensitive stages, while that in adult females was largely ascribable to a reduction of the gonadotropin secretion from the pituitary gland affected by radiation. (auth)

914 A COMPARATIVE ANALYSIS OF THE EFFECTS OF N-NITROSOETHYL-UREA, HYDROXYLAMINE, AND X RAYS ON THE FERTILITY OF MALE MICE. Ramaiya, L. K. (Inst. of General Genetics, Moscow). Genetika, 4: No. 8, 70-80(Aug. 1968). (In Russian).

The frequencies of dominant lethals induced by N-nitrosoethylurea (NEU), hydroxylamine (HA) and x rays in the germ cells of male mice were studied. Chemical mutagenes were injected to the male mice intraperitoneally, the dosage being 100 mg/kg. The males were irradiated with x rays, at dosages of 100, 200, and 400 R. The treated males were mated to the untreated females at 7 to 10 days' intervals during 42 days. It is established that NEU and HA similarly induce a slight reduction of fertility in comparison with the irradiated animals. It was also observed that spermatids and early spermatocytes were genetically the most sensitive to NEU, while the spermatids, medium and early spermatocytes were the most sensitive to HA. The action of chemical mutagens on the germ cells caused the death mainly prior to the implantation. Under the action of NEU on the spermatids the preimplantation loss was equal to the postimplantation death of embryos. Within the range of the stages of spermatogenesis studied the increase of death-rate of the embryos caused by chemical mutagens was not higher than that caused by irradiation with x rays at a dose of 100 R. The effect of NEU and HA on the early spermatocytes was similar to that of x rays at a dose of 200 R. (auth)

915 BIOCHEMICAL DIAGNOSIS OF RADIATION DAMAGE. Gerber, G. B. (Euratom/CEN, Mol, Belgium). pp 468-93 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

The biochemical diagnosis of radiation damage is less specific and less sensitive than cytogenetic and hematological diagnosis. Its advantages, on the other hand, are simplicity of execution and early response. Up to the present there is no ideal biochemical indicator of radiation damage and it is probable that a single indicator can never meet all requirements, but that we need a whole range of biochemical, hematological and cytogenetic means of diagnosis. Various biochemical diagnostic tests are discussed individually, in particular the excretion of creatine, deoxycytidine, taurine, oxyindol acetic acid, pseudouridine and β-aminoisobutyric acid, together with the determination of transaminases and lactic acid hydrase in the blood. A great number of these indicators are at present known only from animal experiments, and with others there are only isolated observations on humans. An adequate number of serum tests on animals under standardized conditions with a large number of indicators are required, together with selected studies on whole-body or partially irradiated patients. Such studies can only be carried out by collaboration between several laboratories. It is also necessary that the samples obtained from the few radiation accidents which occur should be evaluated as exhaustively as possible. (auth)

916 EFFECTS OF X-IRRADIATION ON THE CARDIAC DEVELOPMENT OF CHICK EMBRYO. Gilani, Shamshad H. Buffalo, State Univ. of New York, 1968. 121p.

Thesis.

The effects of x irradiation on cardiac development were studied in chick embryos of two to four days incubation. In all, 1850 fertile eggs were utilized, out of which 220 experimental and 50 control eggs were sectioned for histological and histochemical studies. The LD_{50}'s of chick embryos at normal incubation temperatures (38.5°C) were 800 R (2nd day), 725 R (3rd day) and 860 R (4th day). Embryos kept at room temperature (21°C) for 12 hours prior to irradiation had LD_{50}'s of 800, 725, and 770 R on the second to fourth days, respectively. Embryos kept at room temperature for the same time after irradiation had LD_{50}'s of 750, 765, and 670 R. Cold room temperature (11°C) for 12 hours prior to irradiation led to LD_{50}'s of 750, 765, and 780 R on the second to fourth days, respectively. The same exposure to cold after irradiation led to LD_{50}'s of 600, 635, and 600 R, respectively. The incidence of cardiac anomalies followed the pattern of LD_{50} changes noted above. The number of embryos affected was greater when embryos were exposed to cold after irradiation (65%) than before. The greatest incidence and severity of cardiac anomalies were found after exposure to 11°C after irradiation. (TSS) (Disser. Abstr.)

917 COMPARATIVE EXPERIMENTAL STUDY OF POST-IRRADIATION EFFECTS IN AIR AND HIGH-PRESSURE OXYGEN. Bini, F.; Bordi, C.; Peracchia, G. (Univ., Parma, Italy). Radiobiol. Radioter. Fis. Med., 23: 3-13(Jan.-Feb. 1968). (In Italian).

Mice were subjected to x irradiation in air and in high pressure (3 atmospheres) oxygen. The experiments were performed with 500 and 1,000 R doses, and mortality rates, white cell counts in the peripheral blood, and histological findings of the bone marrow were investigated. Results showed no appreciable difference between the two irradiation procedures; only mortality rates showed a very slight oxygen-induced enhancement. The findings suggest that an increase of oxygen tension does not modify the radiosensitivity of tissues, if these are well oxygenated. (auth)

918 MYCROANGIOGRAPHIC RESEARCH OF GUINEA-PIG KIDNEY AFTER IRRADIATION WITH 20-MeV ELECTRONS. Nicolato, A.; Rodolico, R.; Lombardi, M. (Univ., Pavia, Italy). Radiobiol. Radioter. Fis. Med., 23: 14-26(Jan.-Feb. 1968). (In Italian).

Microangiography was used to determine vascular alterations caused in guinea pig kidney by high energy electrons emitted by a betatron. The results are compared to those obtained in previous studies on the same organ exposed to x irradiation. (auth)

919 CARCINOGENIC PROPERTIES OF INCREASED OXYGEN TENSIONS. I. EFFECTS ON RADIATION-INDUCED MAMMARY TUMORS. Dettmer, Cornelia M.; Kramer, Simon; Gottlieb, Sheldon F.; Aponte, Gonzalo E. (Jefferson Medical Coll. Hospital, Philadelphia). J. Nat. Cancer Inst., 41: 751-6 (Sept. 1968).

It has been reported that exposure to increased oxygen concentrations will enhance the incidence of chemically induced tumors in the lungs of mice. Such effects of oxygen on neoplastic transformation are important in hyperbaric medicine and space programs. To investigate more fully the carcinogenic-enhancing properties of oxygen, the relation of increased oxygen tensions on x radiation-induced mammary tumors in the female Sprague-Dawley rat was studied. The animals were exposed to the following regimen 1 week after 400 RADs whole-body irradiation: 1 hour daily, 5 consecutive days a week for 6 weeks to either 1 atmospheres absolute (ATA) air (Po_2 152 mm Hg), 3 ATA air (Po_2 456 mm Hg), 1 ATA oxygen (Po_2 760 mm Hg), or 3 ATA oxygen, (Po_2 2280 mm Hg). The data indicate that increased oxygen tensions speed up the time of emergence of the primary tumors and enhance the incidence of tumors. Increases in the total number of tumors as well as the number of second tumors per animal were noted. The higher oxygen tensions produced no changes in location or histologic type of tumor. (auth)

920 EFFECT OF PRETREATMENT WITH ENDOTOXIN ON THE RESPONSE OF SKIN TO IRRADIATION IN THE RABBIT. Harcourt, Keith F.; Robertson, Ralph D.; Fletcher, William S. (Univ. of Oregon, Portland). Cancer, 21: 812-15(May 1968).

A double blind study was carried out to determine whether or not bacterial toxins potentiate the effect of x irradiation on normal tissues. Twenty-nine rabbits were given bacterial toxins for 10 days and then received varying dosages of irradiation to the skin of their back. A second group of 30 rabbits was given saline injections and the same dose patterns of single dose irradiation. There were no significant differences between the two groups with regard to erythema dose, onset, duration or intensity of erythema. It is concluded that endotoxin therapy does not potentiate the damaging effects of irradiation to normal rabbit skin. In view of this finding further clinical trials of bacterial toxins and irradiation appear to be justified. (auth)

921 RADIOSENSITIVITY OF THE EMBRYONIC CENTRAL NERVOUS SYSTEM. Semagin, V. N. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Radiobiologiya, 8: 560-4(1968). (In Russian).

On the 18th day of pregnancy in rats of the Wistar line, the uterus was removed from the abdominal cavity, and after shielding of the remainder of the mother's body, subjected to a single irradiation at a dose of 1 R. A sham irradiation was performed on a control group of rats. Investigation of the higher nervous activity in adult rats, irradiated and nonirradiated, was conducted in a semiautomatic apparatus, followed by statistical treatment of the experimental data. X-irradiation of rats on the 18th day of embryogenesis at a dose of 1 R damages the brain, which results in varied disturbances of the higher nervous activity in adult animals. The higher nervous activity is characterized by a weakened excitation and inhibition and a deterioration of the lability. These disturbances are not compensated for during ontogenesis and are lifetime effects. The threshold for damage of the rat embryo brain is a dose below 1 R. The principal cause of the contradictory opinions on the radiosensitivity and radiovulnerability of the central nervous system may be assumed to lie in the objectively existing difference in radiosensitivity and radiovulnerability of its various structures and functions. This circumstance hinders the formulation of a dose versus effect law for the central nervous system. (JPRS)

922 REGENERATION OF STOMACH MUSCLE TISSUE AFTER THE APPLICATION OF MECHANICAL TRAUMA DURING THE EARLY PERIODS OF ACUTE RADIATION SICKNESS. Verzhbitskaya, N. I. (Kalinin Medical Inst., USSR). Radiobiologiya, 8: 529-34(1968). (In Russian).

The results of a study of posttraumatic regeneration of the smooth muscle tissue of the stomach in white rats after the application of mechanical trauma two and seven days after a single total-body x-irradiation at a dose of 700 R are presented. The experiments were conducted for 1 to 40 days. The processes of regeneration of the smooth muscle tissue of the stomach in healthy (nonirradiated) rats after the application of an analogous trauma and the state of the stomach muscles of irradiated rats without additional injury (the same doses and periods of experiments) were studied for comparison. Histological and histochemical methods of staining the preparations were used. The processes of recovery of the stomach muscle tissue occur in normal and irradiated rats. Inhibition of the processes of regeneration of the smooth muscle tissue are the most pronounced in animals that received the mechanical injury seven days after irradiation. (JPRS)

923 EXPERIMENT ON CHRONIC γ-IRRADIATION ON RATS WITH A VARIABLE DAILY DOSE OF THE INFLUENCE. Malakhovskii, V. N.; Laptev, A. I.; Khoruzhenko, A. F.; Oreshkin, I. G.; Rezontov, V. A. Radiobiologiya, 8: 523-8(1968). (In Russian).

A total of 298 rats were subjected to chronic γ-irradiation with linear variation of the daily dose in the direction of a decrease for one group of animals (series A) and in the direction of an increase for the other (series B). At the same time, a model was formulated: the contribution of each daily fraction to the cumulative effect of irradiation is determined by the size of the fraction with its characteristic effectiveness. A prognosis made on the basis of the proposed model basically coincided with the actual experimental results. The differences in death rate between series A and B proved to be directly opposite to what should have been expected on the basis of the widespread Blair–Davidson hypothesis. (JPRS)

924 KINETICS OF RECOVERY PROCESSES IN THE HEMATOGENIC SYSTEM OF MICE AFTER γ-IRRADIATION. Plotnikova, E. D.; Eidus, L. Kh.; Kovalev, V. P. (Inst. of Biological Physics, Pushchino, USSR). Radiobiologiya, 8: 573-81(1968). (In Russian).

The kinetics of the recovery of a population of hematogenic stem cells was studied by the method of fractionated irradiation. The index was the change in the number of colony-forming units (CFU) after irradiation at various non-lethal doses, including the case of preliminary administration of AET. A substantial compensation for the damage to the pool of CFU was detected during the first day after irradiation. Restoration of the pool of CFU is completed by the fourth to fifth day. A hypothesis was proposed, according to which these phenomena are explained by activation of the dormant portion of the pool of stem cells. The results obtained were compared with the pattern of recovery according to the criterion of survival rate of the animals. (JPRS)

925 SOME EARLY CHANGES IN RATS AFTER INJURY BY THE MAXIMUM BLASTOMOGENIC DOSE OF ^{90}Sr. Berezovskii, B. S. (Kazan Veterinary Inst.). Radiobiologiya, 8: 594-9(1968). (In Russian).

In rats that had received the minimum blastomogenic dose of ^{90}Sr intraperitoneally, the functional state of the adrenal cortex was observed for 210 days according to certain physiological and biochemical indices, associated with the corticoid activity, as well as the index of nonspecific immunity — the phagocytic activity of the neutrophils. The phase changes in the corticoid and phagocytic activity found are associated with changes in the absorbed integral dose and the dose rate at various periods of the injury. (JPRS)

926 CHANGES IN THE BLOOD OF BIRDS IRRADIATED WITH FAST NEUTRONS. Dryanovskii, P.; Kovachev, K.; Popov, V. (Higher Veterinary Inst., Sofia). Radiobiologiya, 8: 542-7(1968). (In Russian).

Total-body irradiation of chickens with 2000 RAD of neutrons does not produce any appreciable changes in the erythrocytes of the peripheral blood. However, during the first 65 days after irradiation, the number of reticulocytes in the peripheral blood decreases, and a reticulocytic crisis is established after 5.5 days. The observed morphological changes are characterized by anisocytosis, slight poikilocytosis, polychromatophilia, and a tendency of the erythrocytes for fragmentation. There is a progressively increasing pyknosis of the nuclei and a bud-like separation in some of them. The presence of Türk cells in the peripheral blood of the irradiated chickens indicates an intensive irritation of the bone marrow. The changes in the picture of the white blood cells are characterized by leukopenia, a brief, pronounced pseudosinophilic leukocytosis, lymphopenia, a decrease in the basophils and monocytes, and an almost total absence of eosinophils. The erythrocyte sedimentation rate is accelerated only during the first hour after irradiation. The amount of RNA in the erythrocytes is reduced after irradiation, while the amount of DNA increases somewhat. In a quantitative determination of DNA and RNA in the whole blood of the chickens, it was established that the second wavelengths do not coincide with those proposed by Tsanev and Markov for other tissues. (JPRS)

927 DYNAMICS OF THE CHANGES IN THE BACKGROUND AND INDUCED ELECTRICAL ACTIVITY IN THE VISUAL SYSTEMS OF THE RABBIT BRAIN DURING IRRADIATION. Nadareishvili, K. Sh.; Bakradze, O. S. (Inst. of Physiology, Tbilisi, USSR). Radiobiologiya, 8: 548-59(1968). (In Russian).

The background EEG and induced responses to a light flash were recorded during whole-body irradiation, as well as local influence of x rays on the head and body of rabbits. It was found that the beginning of the radiation influence is accompanied by diffuse desynchronization of the electrocorticogram and activation of various subcortical divisions, especially the RF. The immediate reactions are followed by a complete restoration of the background EEG, while the amplitude of the induced responses is sharply increased. In the case of whole-body irradiation and a local influence on the head, at doses of 13 to 18 kRad, light flashes produce the appearance of spasmodic discharges. After this there is a complete inhibition of the induced responses. Regardless of the localization of irradiation, inhibition of the induced responses occurs in the following sequence: Co-II, Co-I, Rf. The responses in other divisions disappear almost simultaneously. (JPRS)

928 AGE-DEPENDENT RADIOSENSITIVITY OF WHITE RATS. PART III. DETERMINATION OF LD50(30) DURING SUCKLING AND GROWTH STAGES. Reincke, Ursula; Goldmann, Ehrentraud; Mellmann, Juergen; Jesdinsky, Hans-Joachim (Univ., Freiburg i. B.). Strahlentherapie, 136: 349-59(Sept. 1968). (In German).

The LD50(30) was determined in about 4800 Wistar rats that were between 2 and 280 days old. It showed a rapid increase after birth, was unchanged in young animals between 12 and 32 days, and thereafter it increased further to the values obtained in adult animals. There was no significant difference between male and female animals. (auth)

929 X-RAY SENSITIVITY OF SYNCHRONIZED CHINESE HAMSTER CELLS IRRADIATED DURING HYPOXIA. Kruuv, Jack; Sinclair, Warren K. (Argonne National Lab., Ill.). Radiat. Res., 36: 45-54(1968).

Synchronized Chinese hamster cells were irradiated in air and in nitrogen at various points in the cell cycle. The irradiations were carried out after flushing with air or nitrogen with the medium removed from the monolayer of cells. Under these conditions the dose-modifying factor, or oxygen enhancement ratio, was between 2.0 and 2.3 for survival in asynchronous cells. The variation in x-ray sensitivity evident as the cell progresses through its cycle was not differentially affected by its state of oxygenation at the time of irradiation. The x-ray age-response curves for irradiation in air and in nitrogen were similar at each point, except for the dose-modifying factor. This was true not only for the cells of a normal short generation time (10 hours) subline of the V79 line but also for a longer generation time (with longer G_1 period) subline derived from a small colony. The variation in radiosensitivity as the cell progresses through its cycle must therefore be due to factors other than change in oxygen tension within the cell. The fact that the same variation in x-ray sensitivity with age exists for hypoxic cells as for well-oxygenated cells has a bearing on the radiotherapy of tumors which contain cells at low oxygen tensions. (auth)

930 EFFECTS OF IONIZING RADIATION ON THE BONE INDUCTION PRINCIPLE IN THE MATRIX OF BONE IMPLANTS. Buring, Klas; Urist, Marshall R. (Univ. of California, Los Angeles). Clin. Orthopaed. Related Res., No. 55, 225-34(Nov.-Dec. 1967).

Irradiation may be used to sterilize bone for storage in bone banks, but the effects of irradiation upon either the chemical components of the bone matrix or upon the biologic property known as the bone induction principle are not known. Experimental observations made on irradiated bone indicated that 2 to 4 Mrep, the dosage currently in use for sterilization of bone grafts, eliminates the potentiality of the matrix for bone induction. Long bones (decalcified and lyophilized) of adult rats and rabbits were exposed to 0.2 to 37.0 Mrep doses of ^{60}Co γ rays. The samples then were implanted in the muscle of the anterior abdominal wall of adult rats or rabbits, and one to eight weeks later the tissues were examined by radiographic, histologic, and histochemical methods. Samples of bone matrix from both rats and rabbits showed a hardly visible decrease in volume, some shrinkage, and only very slight change in color even at dose levels of 37 Mrep. The solubility of the bone matrix in either 0.5M NaCl or 0.5M citric acid (pH 3.6) as determined by hydroxyproline, hexosamine, or total N in the supernate, was relatively unaltered by doses of 0.5 Mrep. However, solubility of the proteins and the collagen was significantly increased by doses of 2.0 and increased markedly by doses of 37 Mrep. In rats new bone formation was never obtained in any of 300 implants which received a dose exceeding 1.5 Mrep. Instead, the implants evoked a marked inflammatory phagocytic giant cell reaction, and rapidly disintegrated in the fluids of the body. Irradiation made the fibrous proteins more soluble in body fluid or susceptible to phagocytosis and absorption by collagenolytic cells. After a lower dose, 0.2 to 0.6 Mrep, there was some new bone formation even at two weeks, 14 days earlier than generally found in unirradiated controls. As low as 0.5 Mrep doses in rabbits reduced the activity of the bone induction principle; doses in excess of 1.0 Mrep almost eliminated it. Very large doses, sufficient to destroy the structure of the collagen, as well as the bone induction principle, had special effects and restored calcification. (BBB)

931 PROGRESSIVE INTERCAPILLARY GLOMERULOSCLEROSIS IN AGING AND IRRADIATED BEAGLES. Guttman, Paul H.; Andersen, A. C. (Univ. of California, San Francisco. Univ. of California, Davis). Contracts AT(11-1)-34; AT(04-3)-472. Radiat. Res., 35: 45-60(1968).

Specimens of tissue from the kidneys of 168 beagles entered in longevity experiments at the University of California at Davis were examined by light, electron, and fluorescence microscopy. At 10 to 12 months of age, these dogs had received a single exposure or fractionated whole-body exposures to x rays in total doses of 100 R or 300 R. A progressive glomerular lesion was observed in aged, unirradiated control dogs that was similar histologically to the progressive intercapillary glomerulosclerosis (IGS) previously observed in aging rodents. Appearance of IGS was earlier and more advanced in the most heavily irradiated (300 R) dogs. A lesser increase in the severity of IGS was noted in dogs given 100 R in a single exposure or in two fractions of 50 R each. Ultrastructurally, basement membrane thickening, increased mesangial matrix, and electron-dense deposits on the inner surface of the basement membranes characterized the lesion. Gamma globulin (IgG) was demonstrated in the mesangium and basement membrane in both normal aging dogs and in irradiated dogs. In view of these findings, the possible role of an immune factor in the pathogenesis of progressive IGS in aging and in irradiated dogs was considered. (auth)

932 RECENT DEVELOPMENTS IN FUNDAMENTAL RADIOBIOLOGY. Epp, Edward R. (Sloan-Kettering Inst. for Cancer Research, New York). Cancer, 22: 802-8(Oct. 1968).

Recent developments in three areas of radiobiology of interest to radiotherapy are reviewed. These areas are: experiments designed to evaluate the effect of local tissue oxygenation, tumor volume and fractionation on the dose required to control murine mammary carcinoma; experiments designed to investigate the oxygen effect in cells which are exposed to extremely short pulses of radiation; and experiments designed to examine the possibilities for negative pi mesons in radiotherapy. (auth)

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Refer also to abstracts 772, 850, 862, 864, 872, 887, 894–896, and 901.

933 (NIRS-6) ANNUAL REPORT [ON RADIOLOGICAL SCIENCES], 1966. (National Inst. of Radiological Sciences, Tokyo (Japan)). Oct. 1967. 80p. Dep.

Brief reports are given of 168 research projects conducted at the National Institute of Radiological Sciences in Japan. The reports are grouped according to the following areas of interest; physics, dealing primarily with the instrumentation used in quantitating radiation doses and exposures; chemistry, the preparation and analysis of compounds used in the qualitative and quantitative determinations of radioisotopes; biochemistry and biophysics, the effects of radiation on biochemical processes and molecules, and the biosynthesis of organic molecules; cytology and morphology, studies of the fine structure of tissues and the effects of radiation on them; physiology, the effects of radiation on physiological processes in organisms; genetics, the mutagenic effects of radiation and its effects of all levels; medical studies, the amelioration of radiation doses to patients during diagnostic and therapeutic applications of radiation; and environmental studies, methods for the determination of the radioisotope content of materials significant to man's well being and surveys of these materials. (E.R.B.)

934 (TID-24521) GAMMA IRRADIATION OF BIRDS EGGS AND THE RADIOSENSITIVITY OF BIRDS. Bulletin No. 561. Wetherbee, David Kenneth (Massachusetts Cooperative Wildlife Research Unit, Amherst. Massachusetts Agricultural Experiment Station, Amherst). Oct. 1966. Contract AT(30-1)-3229. 103p. Dep. CFSTI.

Original data and a review of other research on the effects of radiation on hatchability of birds' eggs and the effects upon subsequent fertility (consequent fertility) of wild bird species are presented. Eggs of the various species mentioned (Coturnix coturnix, Columba livia, Gallus sp., Passer domesticus, Larus argentatus, Larus marinus, Sturnus vulgaris, Agelaius phoenicius, Quiscalus quiscula, Phalacrocorax auritas, Somateria mollissima, Pekin duck, and white China goose) were collected either in the field or from captive colonies and randomized as to freshness before being irradiated with acute doses at a dose rate of 333 R/minute. The majority of the original data pertained to quail (Coturnix coturnix). The lethal effects of γ radiation on eggs of the quail were most noticeable when it was applied during the first nine days of incubation; eggs irradiated after that time were much less radiosensitive. During this early phase of incubation the lethal effects were minor at 500 R, greater than 50% at 700 R, and complete at 900 R. After the ninth day of incubation, γ irradiation in the range of 700 to 1300 R had a minor (less than 50%) effect on the survival of embryos to hatching. The lethal effects of γ radiation on eggs of the rock dove (Columba livia) were noticeable at each of the first five days of incubation at 700 R; after this period the eggs seemed to be more radioresistant; at 900 R hatchability was depressed completely during early incubation, and drastically reduced during later stages of incubation. The variations in radiosensitivity of birds' eggs at 0-days incubation were attributed to impossibility of standardizing fresh eggs. (B.S.L.)

935 THE CONSEQUENCES OF THE RADIOSENSITIVITY OF HEMOPOIESIS FOR THE EVALUATION OF RADIATION INJURY. Fliedner, Th. M. (European Atomic Energy Community. Gesellschaft fuer Strahlenforschung m.b.H., Freiburg i. B.). pp 105-31 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

After a brief review of radiation accidents before 1945 the present problems of evaluating radiation accidents are discussed.

The types of radiation accidents and categories of clinical consequences are described. Hematological observations after accidental whole-body radiation exposure are examined. These observations include granulocyte, lymphocyte, and platelet changes in individuals exposed to sublethal and lethal doses of ionizing radiation. The central role of hemopoiesis for evaluation and management of radiation injury is evaluated by reviewing the distribution of hemopoietic tissue in the body, internal structure of cell renewal systems, consequences of radiation exposure of each component of a cell renewal system. Guidelines for the evaluation of accidentally exposed persons are included. (B.G.D.)

936 GROWTH IMPAIRMENT FOLLOWING RADIOTHERAPY IN CHILDHOOD. Dawson, W. B. (Clatterbridge Hospital, Bebington, Eng.). Clin. Radiol., 19: 241-56(July 1968).

The biological and physical mechanisms involved in growth impairment caused by radiotherapy and the degree of disability to be expected following radiotherapy in childhood are discussed. The literature is reviewed with special regard to the effect of radiation on young bone. Sensitivity is found to be more marked the younger the subject and the more actively growing the tissue irradiated. Developmental impairment of an irradiated bone is symmetrical after uniform irradiation in the absence of mechanical strain: asymmetrical irradiation and uneven stress give rise to uneven growth. There is some evidence that bone growth is more seriously impaired by lower than by higher voltage irradiation. The records of the Liverpool Regional Radiotherapy Service were analyzed and 35 patients irradiated in childhood were examined. Developmental impairment of muscle and fat was as conspicuous as that of bone. It was concluded that maldevelopment of these tissues was probably caused by a fundamental effect of radiation on the growing cell rather than to radiation fibrosis. The effect of x rays on breast and tooth development was noted. Clinical observation supported the experimental evidence that the effect of radiation on bone is greater for younger subjects and for lower voltage radiations. Although many of the Liverpool patients showed obvious growth impairment, none showed any marked degree of functional incapacity. When treating children with radium and x rays every effort should be made to protect such important and sensitive structures as the breast and epiphyses. But, when radiotherapy is life-saving, some degree of deformity may be the price of survival. (auth)

937 PSYCHOLOGICAL ASPECTS INHERENT IN ACCIDENTAL IRRADIATIONS AT THE PLACE OF WORK. Sivadon, P. (Centre de Recherches Psycho-Pathologiques, Paris); Fernandez, A. pp 617-25 of Accidental Irradiation at Place of Work. EURATOM, 1967.

From Symposium on Accidental Irradiation at Place of Work, Nice. See EUR-3666; CONF-660412.

A recapitulation of the psychological features of nuclear work is presented. An analysis is made of the various psychological factors involved in some typical accident cases. An attempt to explain the function of psychological aspects of accidents and the introduction of preventive measures are included. (B.G.D.)

938 COMPLICATED LESIONS OF FACE AND JAWS IN ACUTE POSTIRRADIATION INJURIES. Boszkiewicz, Tadeusz (Stomatologic Clinic, Warsaw). Czas. Stomatol., 19: 657-63 (June 1966). (In Polish).

Surgical treatment of oral injuries complicated by postirradiation effects is reviewed. Radiation effects at 5 dose levels are discussed: 0 to 100 R, generally no morbid symptoms; 100 to 200 R, a mild stage with 2% fatalities; 200 to 300 R, an intermediate stage with 5 to 15% fatalities; 300 to 500 R, the severe stage with 10 to 80% fatalities; above 500 R, a very severe stage with 80 to 100% fatalities. Clinical substages include: The initial reaction, which usually runs a mild course. It lasts for a few hours to a day or two, and is manifested by nervous agitation, headache, dizziness, fatigue, and vomiting. The latent stage lasts from several hours to 2 weeks, and seldom advances to a severe course. The fully developed radiation disease lasts from several weeks to several months. The convalescence stage lasts from several weeks to several months. The surgical procedures and techniques are detailed on the setting roots, and eventual restoration of missing bone by plastic surgery. The latent stage is the most convenient one for corrective surgery if healing occurs before progression to the 3rd stage. Otherwise, the suppurative response may increase the severity of and prolong postirradiation sickness, and even result in gangrene. Also discussed is the necessity for prophylactic precautions to be observed in the personnel treating the patients, and for maintaining strict asepsis during surgery. (TSS) (BBB)

939 COMBINED RADIUM THERAPY AND RADICAL HYSTERECTOMY WITH PELVIC LYMPHADENECTOMY IN TREATMENT OF INVASIVE CANCER OF THE CERVIX. Villasanta, Umberto (Univ. of Maryland, Baltimore). Obstet. Gynecol., 32: 6-10(July 1968).

Results of Ra application followed by radical operation for treatment of Stage I carcinoma of the cervix were evaluated. The irradiation consisted of a single Ra application of 30 to 75 mg of Ra in a sac or tandem inserted into the endocervical canal and a gauze plaque containing between 60 and 80 mg of Ra placed contracervically. The total dose delivered varied between 4500 and 5000 mg-hr. The mean interval between Ra application and operation was 51 days, with a range of 13 to 265 days. The delayed complications were probably consequences of the irradiation therapy. In 7 patients the delayed complications appeared between 4 months and 3 yr following the treatment. Not 1 fistula developed in 56 patients. The incidence of debilitating complications was 3.5%. The duration of time between the Ra application and the radical hysterectomy did not appear to influence the incidence or type of complications. (TSS) (BBB)

940 MAJOR UROLOGIC COMPLICATIONS FOLLOWING RADIUM AND X-RAY THERAPY FOR CARCINOMA OF THE CERVIX. Cushing, Robert M.; Tovell, Harold M. M.; Liegner, Leonard M. (St. Luke's Hospital Center, New York). Amer. J. Obstet. Gynecol., 101: 750-5(July 15, 1968).

Retrospective study was undertaken to determine the immediate and late major urologic complications associated with Ra and x-ray therapy of carcinoma of the uterine cervix. The duration of Ra application ranged between 24 and 36 hr, resulting in 400 R/hr to point A. The radiation sequelae in the urinary tract were attributed to Ra therapy rather than to external x-ray therapy, since the latter was directed only to the parametria. Parametrial tissue doses of 2400 to 3000 R were given with multiple portals, including perineal fields. There were 10 patients with urinary complications attributed to Ra therapy alone. Vesicovaginal fistulas developed in 6 patients at 7 to 27 months. Of the remaining 4 patients, 2 developed extensive ulcerations of the bladder with advanced renal infection in 1, and 2 patients developed complications resulting from ureteral obstruction. The time of onset of the major urologic complications due to Ra was ~12.3 months. Of these 10 patients, 3 were alive and well at 10, 17, and 25 yr, respectively, following treatment, and the remaining 7 patients lived for a mean survival time of 4.5 yr. Only a mild early mucosal reaction will be produced by doses of 3000 R delivered to the urinary bladder in 4 weeks by external radiation. The bladder will tolerate local Ra implants up to 8000 R. With Rn seed implants, a minimum dose of 7000 R γ radiation was used with few complications. After 6000 to 10,000 R of γ radiation from a central source of Ra in 50 patients, 10 developed severe acute reactions, 7 developed late reactions, 17 developed only mild reactions, and 16 showed no reactions at all. There were no bladder complications in $^2/_3$ of 42 patients with bladder cancer treated with a calculated tumor dose of 6000 R of ^{60}Co. (TSS) (BBB)

941 HYPOTHYROIDISM AND ^{131}I THERAPY. Greig, William R. (Royal Infirmary, Glasgow). Brit. Med. J., 2: 250(July 27, 1968).

The major problem of conventional radioiodine treatment for thyrotoxicosis is that it produces a high rate of hypothyroidism. Reduction of ^{131}I dose reduces the ultimate hypothyroid rate, but supplementary antithyroid drug treatment is required to help control the thyrotoxicosis. The combination of antithyroid drugs and radioiodine therapy is not as convenient for the patient and physician as radioiodine therapy alone. If, however, ^{131}I is used alone, radiation injury throughout the thyroid is extensive and few follicular cells survive. Cellular irradiation injury from ^{125}I is theoretically more focal than that from an equivalent radiation dose from ^{131}I, and experiments in animals confirmed this. The author has begun a study employing ^{125}I in the treatment of thyrotoxicosis in the hope that ^{125}I irradiation of the thyroid cells will be extensive enough to cure the thyrotoxicosis but that the irregular distribution of irradiation within the thyroid will allow enough cells to survive to prevent subsequent hypothyroidism. If ^{125}I is successful by these criteria, the advantages of simplicity of radioiodine therapy for thyrotoxicosis will be maintained. (BBB)

942 CHANGES IN THE GUSTATORY SENSITIVITY OF THE TONGUE IN RADIOTHERAPY OF NEOPLASMS OF THE TONGUE AND SUBLINGUINAL REGION. Peregudova, G. N.; Budylina, S. M. (Medical Stomatology Inst., Moscow). Stomatologiya, 46: 53-6(July-Aug. 1967). (In Russian).

Studies are reported on 27 patients (19 males, 8 females), aged 27 to 77 yr, who developed histologically-verified malignant neoplasms of the tongue and mouth. For radiotherapy, x-ray and tele-γ sources were used, with average doses of 6500 to 8000 R, or 6400 to 7800 RAD. Doses of 1000 to 1500 RAD induced hyper-

emia and dryness of the tongue, also viscous white deposits on it. With increased doses, up to 2000 RAD, the dorsum of the tongue lost its velvety appearance and developed an unremovable white-yellowish fur owing to keratinization of the epithelium, while on the lateral surfaces of the tongue imprints of teeth appeared, with focally atrophied papillae. Doses up to 3000 RAD intensified these changes, and desquamation of the epithelial surface became visible. Higher doses, up to 6000 RAD, progressively induced a confluent appearance of the above-described radiation effects. Impairment of gustatory sensitivity of the oral cavity was present in 85% of the patients prior to the beginning of their treatment. The tests included 4 basic tastes: sweet, salty, sour, and bitter. As the treatment of neoplasms with x rays and Ra continued, a total loss of the gustatory sensitivity in the oral cavity of the patients resulted. (BBB)

943 REPORT OF ONE CASE OF ACUTE LEUKEMIA FOLLOWING THE TREATMENT OF HYPERTHYROIDISM WITH ^{131}I. Wu, Kuo-liang; Ch'en, Chang-tseng; Ch'en, Ch'ing-en; Hsiao, Chin; Shen, Kuo-chun (Nanking Military General Hospital, China). Chung Hua I Hsueh Tsa Chih, 11: 660-2(Aug. 1963). (In Chinese).

Since 1942, ^{131}I has been applied clinically to treat hyperthyroidism. If an excessive amount of ^{131}I is applied, thyroid deficiency may result. The rate of occurrence of this side-effect is 8 to 18%. The occurrence of leukemia following this treatment has been occasionally reported in foreign countries, but not in China. This paper reports one case of monocytic leukemia occurring 15 months after the patient was treated with ^{131}I for hyperthyroidism. The case history and the autopsy report are included. (JPRS)

944 THOROTRAST INJURIES. Roloff, Wolfgang (Klinik des Bezirkskrankenhaus Heinrick Braun, Zwickau, Ger.). Z. Aerztl. Fortbild., 60: 488-95(Apr. 15, 1966). (In German).

Characteristics of Thorotrast, its decay pattern, and its injurious biological effects are discussed. Induction of tumors by Th in experimental animals and in patients is described. Although the incidence of Th tumors is low, considering its previous rather extensive use, its fibrogenetic effects are considerable. Thorotrastomas are considered to be precancerous. The carcinogenic effects of Th probably are due to the summation of its irradiation effects after prolonged deposition and retention. The latency time between Th administration and evidence of tissue damage varies widely from 3 to 35 yr. In addition, wide variations in Th retention have been observed. Late injuries from prolonged retention of Th include thorotrastomas. These may affect nervous tissue, vascular components, liver, spleen, kidney, lymphatic system, and bone marrow. The characteristics and diagnosis of thorotrastosis are described in detail and numerous examples are presented. 51 references. (BBB)

945 THOROTRAST DAMAGE. Zintl, Ludwig (Staedtische Krankenhaus, Schwenningen/Nekar, Ger.). Med. Welt, 17: 1339-40(June 11, 1966). (In German).

Histological evidences of Thorotrast deposition in the liver of a patient are described. These included proliferation of connective tissue, considerable expansion of the Glisson triangle, enlargement of cells, and, frequently, appearance of binucleated cells and a conspicuous, pale grey-brown pigment within the connective tissue cells of the Glisson triangle. The pigment particles were very refractive to light and did not give an Fe reaction. A similar pigment was observed in the Kupffer cells. A pigment that contained Fe was also found in the Kupffer cells and connective tissue cells of the Glisson triangle. Because of the pattern of distribution and the nature of the Fe-free pigment it was considered to contain Th. This was confirmed by x-ray studies of the abdomen, where typical evidence of Th incorporation was obtained. The spleen was contracted and was densely saturated with deposits of the size of the head of a needle. In the liver the Th deposits were larger. There were gross streaks across the center of the epigastrium that indicated Th deposits in the periportal and perioaortic lymph glands. (BBB)

946 PHYSIOLOGIC CHANGES BEFORE AND AFTER RADIATION TREATMENT FOR CARCINOMA OF THE LUNG. Germon, Patricia A.; Brady, Luther W. (Hahnemann Medical Coll., Philadelphia). J. Amer. Med. Ass., 206: 809-14(Oct. 21, 1968).

Physiologic data concerning 30 patients with bronchogenic carcinoma were obtained before radiation therapy and at intervals thereafter. At pretreatment examination, abnormalities were found in all patients. Postirradiation data revealed decreased residual volumes and diffusing capacities with little progression of airway obstruction. No parameter evaluated demonstrated correlation with the volume dose of the tissue irradiated. Pretreatment lung scintiscans disclosed areas of decreased capillary blood flow which were greater at times than would be suggested by chest roentgenograms. Postirradiation lung scans showed further decreases in the pulmonary capillary blood flow in areas initially affected. It is suggested that alterations in the capillary blood flow and resultant tissue changes were initiated by tumor and aggravated by radiation therapy. The data do not confirm other reports attributing the development of severe pulmonary disability to radiation therapy of the lung. (auth)

947 CLINICAL RADIATION PATHOLOGY AS APPLIED TO CURATIVE RADIOTHERAPY. Rubin, Philip; Casarett, George W. (Univ. of Rochester, N. Y.). Cancer, 22: 767-78(Oct. 1968).

The value of radiation pathology in understanding the radiation effects in normal tissues and tumors is stressed in developing curative radiotherapy. A theory of cell radiosensitivity is presented based on cellular proliferation, differentiation and life span. From this base, concepts of tissue and organ radiosensitivity are developed utilizing the knowledge of tissue organization, cell kinetics and microcirculation. Through a series of paradigmatic charts and drawings an attempt is made to explain different clinical manifestations of radiation reactions on the basis of similar histopathologic changes. Possible future directions for radiation research to explore are outlined. (auth)

948 THE RADIOLEUKEMIAS. Rudali, G. (Foundation Curie, Paris). Med. Interna, 19: 131-40(Feb. 1967). (In Rumanian).

Radioinduced leukemia and the leukemogenic process in men and mice were studied. Human radioleukemia occurred infrequently, probably due to the low sensitivity of man to the action of radioleukemogenic factors. Radioleukemia in mice was discussed in detail on the basis of experimental data. Technical conditions for induction of radioleukemia were presented. The influence of heredity, hormones, and age were explored, and coleukemogenic factors explained. Possible mechanisms of radioleukemogenesis were examined. The viral aspect of radioleukemia was elaborated. Then the cellular concept of radioleukemia was expounded. The role of various organs, such as the thymus gland, in leukemogenesis was discussed. In conclusion the parallel between spontaneous leukemia and that elicited by x radiation was drawn. Irradiation was considered one of multiple causes for inciting neoplasia in an already predisposed area. (BBB)

Radiation Effects on Plants

Refer to abstracts 774, 807, 809, 811, 813, and 960.

Radiation Effects on Microorganisms

Refer also to abstracts 777, 810, and 1728.

949 EFFECTS OF X RADIATION ON STATIONARY AND EXPONENTIALLY INCREASING HAPLOID YEAST POPULATIONS. de Langguth, E. N.; Pohlit, W. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 4: 320-8(1968). (In German).

With the help of the length growth of cell buds, the age distribution of a stationary population of haploid yeast cells was determined. From the dose effect curve for x radiation for stationary and exponentially increasing cells, the limits for a radiation resistant range in the age distributions were determined. It was determined that there are diploid or bud-carrying cells in these resistant cells. From this model a prediction can be made as to the effects of a second irradiation occurring after an arbitrary interval. The fraction of resistant cells N_R/N_0 should almost equal 1 after irradiation with 10 kRad; it should first decrease with the interval t_p and after a minimum of $N_R/N_0 = 0.3$ at $t_p =$ 60 min it should again increase to 1. This prediction was experimentally tested and confirmed although scattering of the lag time induced by the irradiation was observed. In the analysis of dose-effect curves of yeast cells at least two different cell states must be considered. Additional studies are necessary in order to determine how these two cell states lead to different types of radiation reactions. (tr-auth)

950 OBSERVATIONS ON SINGLE CELLS OF X-IRRADIATED HAPLOID YEAST CELLS. de Langguth, E. N.; Pohlit, W. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 4: 329-42(1968). (In German).

A model was formulated previously for the effects of x radiation on a non-synchronized population of haploid cells of yeast, in which two different radiation-sensitive age intervals were detected, that can be confirmed by the method of single cell observation. The radiation effect on the radiation-sensitive state A_1 leads first to injury which is always manifest in the following division of the

nuclear material. The effect on the radiation-resistant state A_R leads first to an induced lag time of quite differing lengths. Long lag times are observed in those cells which can be developed later to macrocolonies. This suggests that during this lag time opportunities for recovery processes occur. Cells with shorter induced lag times remain in groups with 4 to 32 cells after the irradiation and were inactive after a few cellular divisions had occurred. This indicates a genetic radiation damage in this group. (tr-auth)

951 STUDIES ON THE RADIATION RESPONSE OF MICROCOCCUS RADIODURANS. Serianni, Richard Walter. Buffalo, State Univ. of New York, 1968. 97p.

Thesis.

Micrococcus radiodurans when grown at 30°C in complete YHC medium or in a chemically defined synthetic medium exhibits a phasic response to x irradiation but not to uv irradiation. The culture progresses from a relatively radiation sensitive state during the exponential portion of the growth cycle to an extremely resistant condition upon passage into stationary phase. The increase in resistance, which results in an increase in the LD_{90} from approximately 250 kR to approximately 600 kR, is primarily the result of an extension of the shoulder of the survival curve. Estimates of the quasithreshold dose (Dq), or dose below which cell lethality does not appear to be occurring, indicates that stationary phase cells are capable of absorbing an additional 150,000 R before cellular inactivation begins to occur at an exponential rate. Two theories are examined in an attempt to explain the basis for the phasic response to x irradiation exhibited by this organism. (TSS) (Disser. Abstr.)

952 ENVIRONMENTAL EFFECTS AND TRANSFER EVENTS DURING PRIMARY INFECTION OF WHEAT BY ERYSIPHE GRAMINIS. Mount, Mark Samuel. East Lansing, Mich., Michigan State Univ., 1968. 123p.

The various components of primary infection of wheat by E. graminis were investigated. On the basis of morphological changes and differential sensitivity to environmental conditions, the components of primary infection of powdery mildew were determined. They are: germination; formation of appressorial initials; maturation of appressoria; penetration; haustorial development; formation of secondary hyphal initials; and formation of functional or elongating secondary hyphae. The degree of a successful host-parasite relationship was correlated with the number of functional secondary hyphae and haustoria formed. The critical environmental condition necessary for synchronizing the rate of formation of functional secondary hyphae is that the inoculated plants be subjected to darkness from 6 to 20 hr after inoculation. It is during this dark period that penetration and haustorial development take place. Approximately 60% of the mature appressoria produced penetration pegs by 10 to 12 hr after inoculation. High light treatments given at various hours after inoculation clarified further by differential sensitivity that secondary hyphal initials and functional secondary hyphae were indeed separate stages of the primary infection process. Ultraviolet light was used as a tool in determining the time after inoculation that the haustorium is functional within the epidermis. Experiments showed that the epidermis could function as a protective barrier against uv radiation. The parasite began losing its sensitivity to uv radiation at the 14th hr after inoculation, indicating that the haustorium had developed sufficiently in the host to be protected by the host. If the haustorium had not developed sufficiently within the epidermal cell, uv radiation killed the fungus. Nuclear migration into the haustorium was first observed 16 hr after inoculation. Appendages formed at the ends of the haustorial bodies by 18 hr after inoculation. The determination of isotope transfer from host to parasite further defined the initial infection process. An interpretation of the data suggested that possibly two mechanisms of ^{32}P and ^{35}S transfer (one, a low transfer from 12 to 16 hr, and the other, a high transfer from 16 to 24 hr after inoculation) exists with a susceptible host-parasite interaction. A high transfer of radioactivity was first detected at the 18th hr which corresponded with the formation of appendages on the haustoria. (Diss. Abstr.)

953 ESTIMATION BY THE MAXIMUM LIKELIHOOD METHOD OF SURVIVAL CURVES OF IRRADIATED MICROORGANISMS. Lellouch, J.; Wambersie, A. (Inst. Gustave Roussy, Villejuif, France). Biometrics, 22: 673-83(Dec. 1966). (In French).

Methods for the estimation of survival curves of irradiated microorganisms were examined. Two cases were considered: in the first, the number of targets per organism was known a priori; the only unknown parameter was the slope of the straight line relating the logarithm of the percentage of organisms surviving to the radiation dose. In the second, the number of targets was unknown, and was therefore estimated. How estimation was made by maximum likelihood, assuming Poisson variation, was described and two examples were given. The problem of comparison and the case when the assumption of Poisson variability was untenable were also discussed. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstract 703.

954 PROTEIN QUALITY OF IRRADIATED SHRIMP. Reber, Elwood R.; Bert, Mark H. (Univ. of Massachusetts, Amherst). J. Amer. Diet. Ass., 53: 41-2(July 1968).

The protein quality and protein efficiency ratio (PER) of white shrimp, Penaeus setiferus, after commercial processing, and γ irradiation at levels of 0.15 and 0.30 megaRad, cooked for 2 min at 102°C, or left untreated was evaluated after freeze-dehydration, using rats. A statistical analysis of PER values for individual rats was carried out. The variance for the treatment times replication interaction was not significant, but the variance for treatments and that for replications was significantly large. The variance for treatments was significantly large only because the mean PER value for casein, 3.13, was significantly lower than any of the other treatment mean PER values. The mean PER values for whole-egg solids, nonirradiated shrimp, irradiated shrimp, and cooked shrimp were statistically equal. (BBB)

955 RADIATION PROCESSING OF FOODS. HEARINGS BEFORE THE SUBCOMMITTEE ON RESEARCH, DEVELOPMENT, AND RADIATION OF THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, EIGHTY-NINTH CONGRESS, FIRST SESSION, JUNE 9 AND 10, 1965. Washington, D. C., Joint Committee on Atomic Energy, 1965. 826p. GPO $2.50.

956 MICROWAVE DEHYDRATION OF POTATOES AND APPLES. Huxsoll, C. C.; Morgan, A. I. Jr. (Western Utilization Research and Development Div., Albany, Calif.). Food Technol., 22: 47-52(June 1968).

Effects of 915-MHz microwave radiation at a power of 25 KW on potatoes and apples are described. It was pointed out that microwave radiation had three advantages in food processing: a penetrating quality which effected uniform heating of materials upon which the radiation impinged, selective absorption of the radiation by liquid water, and a capacity for easy control so that heating could be rapid if desired. However, limitations on heating rate existed due to such factors as the geometry of the food pieces and the uniformity of the load. When a piece of potato dice was dried to about 20% moisture and then exposed to microwave energy, the residual moisture contained in a wet core inside the piece was rapidly converted to vapor. If the heating was sufficiently rapid, the rate of vapor formation would be such that the piece would expand or puff. For a single application of microwave energy, the most desirable end-product was obtained if the potato dice was air dried to about 45% moisture and then placed in the microwave tunnel. In contrast to potatoes, which contain primarily starch, apples are particularly high in simple sugar content. This led to slow dehydration, especially if very low final moisture levels were desired. (BBB)

957 COMPARATIVE STUDY OF CLASSICAL STERILIZATION AND RADAPERIZATION OF FOOD DESTINED FOR THE RAT. Ferrando, R.; Pantaleon, J.; Fromageot, D. (Ecole Nationale Veterinaire, Alfort, France). Ann. Nutr. Aliment., 22: 25-7(1968). (In French).

A study was made in rats to compare radiation-sterilized food with conventionally sterilized food for nutritional and other qualities. Male rats of an average weight of 40 g were divided into three groups of nine each and were maintained for 30 days at 23°C, 70% relative humidity under continuous uv irradiation. Animals were weighed twice a week. The first group was the control group; the second received food sterilized by autoclave at 115°C for 80 min; the third received food sterilized by a dose of 4.5 Mrad of γ rays. Tables showed results of chemical and bacteriological analyses, overall performance, and protein efficiency of the various foods. Food sterilization by γ radiation offered better protection against infections as well as increasing growth and protein utilization efficiency. Conventional (heat) sterilization produced less protein efficiency and less growth than normal food in the control group. No abnormalities were observed in the rats receiving any of the diets. (BBB)

958 PROSPECTS OF INTEGRATED MICROBIAL AND RADIATION CONTROL OF HARMFUL INSECTS. Jafri, R. H. (Panjab Univ., Lahore). J. Invertebr. Pathol., 9: 293-7(Sept. 1967).

Combined microbial and radiation control methods applied to

insect pests were considered. Studies of the radiosterilization method of population suppression showed that ionizing radiation would induce sterility but there was considerable variation in the amounts needed. It was also suggested that radiation damage could prevent use of the method on some insects. In nature, some insects were so abundant that the use of the sterile-male technique would not be feasible without first applying to the geographically isolated and nonisolated infested area other control measures to bring wild populations to certain limits. Thus, the population could be controlled by microbial pathogens. Also, the release of sterile male insects carrying parasites or pathogens offered control possibilities. The increased susceptibility of irradiated insects to pathogens opened a new field of investigation. The life span of Tribolium castaneum and T. confusum beetles was shortened considerably when the test insects were inoculated with Bacillus thuringiensis immediately and 24 and 144 hr following exposure to x rays. The life span of the irradiated beetles was shortened by the presence of Farinocystis tribolii, Nosema whitei, and Adelina tribolii, protozoan parasites in the fat body of the test insects. Prospects of developing, through irradiation, new strains of pathogens of high virulence were discussed. Strains of increased virulence of Beauveria bassiana and Aspergillus flavus were isolated after ionizing irradiation. Economic feasibility in using ^{60}Co γ radiation in the control of diseases of the honey bee, and in the sterilization of honey, was discussed. (BBB)

959 STERILIZATION OF BONE TISSUE WITH ^{60}Co GAMMA RAYS. Sautin, E. N. (Inst. of Traumatology and Orthopedics, USSR). Ortop. Travmatol. Prot., 27: 56-61(Apr. 1966). (In Russian).

Sterilization of bone tissue by large doses of ^{60}Co γ rays and the reaction of the recipient to the transplantation of sterilized bone are reported. Only lyophilized tissue was γ irradiated. Bacteriological cultures of bone prepared under nonsterile conditions revealed various types of bacilli and cocci indicating contamination even after freezing and lyophilization. Repeated bacteriological tests showed that lyophilized bone tissue treated by γ rays became sterilized. The enzymes aldolase and alkaline phosphatase were not significantly affected by doses of γ rays used. Tissue after treatment lost the ability to take up oxygen. Differences in lyophilized tissue prepared under sterile conditions and that sterilized by γ rays could not be found. The reaction of recipients to transplanted sterilized bone was studied in rabbits using lyophilized bone prepared under sterile conditions for controls. Edema appeared on the third day and decreased on the seventh day. The day after the operation and in the third week a rise in the white blood cell count was noted but after one month white and red blood cell counts were normal. Microscopic study showed in the third week an erosion of bone tissue from the surface of the graft, indicating resorption and rebuilding of the transplanted bone. By the 30th day expanded vascular channels were seen. By the 60th day the rebuilding process had spread. After one yr when the substitution of new transplanted bone had taken place without complication, it was possible to see the borders of the original defect. These results, establishing the possibility of the successful use of sterilized bone experimentally, suggested the possible use of similar bone transplantations under clinical conditions. (BBB)

960 THE BIOLOGICAL EFFECTS OF POTATO SEED IRRADIATION AS AFFECTED BY THE DURATION OF STORAGE BEFORE AND AFTER THE TREATMENT. Solomko, E. A. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Sel'skokhoz. Biol., 2: 129-31(1967). (In Russian).

The effect of ^{60}Co γ irradiation (doses of 15, 25, and 30 KR) of potato seed on the rate of germination as affected by storage before and after irradiation was studied. The results showed that the radiobiological effect on potato seed depended on the state of seeds and conditions under which they were stored before and after the treatment. Irradiation of potato seed that had passed the dormancy stage and was planted 12 days and four months after the treatment did not strongly inhibit the rate of germination, but suppressed the development of plants and considerably reduced their survival as compared with control plants. Seeds that were treated in the dormant stage were more radioresistant. Their germination after four months storage following treatment was not affected, but the number of plants that survived by the end of the growing period was lower than in the control by 23.3%. However, when such seeds were stored for 16 months after irradiation only 3.5% of plants survived by the end of the growing period. (BBB)

961 IRRADIATION EFFECTS ON THE RIPENING OF KENT MANGOES. Dennison, R. A.; Ahmed, E. M. (Univ. of Florida, Gainesville). J. Food Sci., 32: 702-5(1967).

Mango fruit irradiated with ^{60}Co at doses of 0, 100, 200, and 300 Krad was ripened at 20°C for 0, four, and eight days. Irradiated mangoes were less firm than control fruit immediately after irradiation, but softening due to ripeness was more pronounced than softening induced by irradiation. Irradiated fruit contained higher water-soluble and lower Versene-insoluble pectic fractions as compared to unirradiated fruit. No differences were observed in the content of the Versene-soluble fraction among irradiation doses. Higher pectinesterase (PE) activities were exhibited by the irradiated fruit throughout the ripening period. Irradiated fruit contained higher alcohol-insoluble solids (AIS) and lower soluble solids than control fruit. No differences in sucrose content due to irradiation were observed, but there were less reducing and total sugars at 300 Krad compared to other doses. Changes in pectic fractions and PE activity were more pronounced immediately following irradiation than during ripening. The increase in soluble solids as well as sucrose, and the decrease in AIS, titratable acidity, reducing sugars and firmness during ripening was faster in control than in irradiated fruit. These variable rates of change were reflected by the significant irradiation dose and storage duration interactions. The results suggested that irradiation induced a delay in ripening of Kent mangoes. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 104, 345, 351, 352, 357, 528, 1020, 1991, 2053, and 2065.

962 (IS–1900, Paper 5) METALLURGY DIVISION. Spedding, F. H.; Smith, J. F.; Bailey, D. M.; (and others) (Ames Lab., Iowa). 105p.

Research progress is reported on preparation and purification of metals for fuels and cladding, phase diagram studies of reactor materials, diffusion and transport by liquids and gases, properties of surfaces, radiation damage, and preparation and properties of rare earths and rare earth compounds. (J.R.D.)

963 (NP–17579, pp V.3) METALLURGICAL SERVICES. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

A brief review of activities related to metallographic examinations is presented along with a list of activities associated with forming and welding metals. (J.R.D.)

Corrosion and Erosion

964 (AECL–2732) SURFACE TREATMENTS TO IMPROVE THE WEAR RESISTANCE OF TYPE 304 STAINLESS STEEL IN WATER. Ogunlade, O.; Watson, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1968. 27p. Dep. CFSTI. CAN $1.00.

Various surface treatments were applied to 304 stainless steel journals in an attempt to improve their wear resistance. The treatments consisted of one or more of the following; shot-blasting with Glas-shot or chilled-iron-shot, heating in air, in argon containing air or in vacuum. The treated journals were tested against Waukesha 88 bearings at loads of 20, 40, and 60 lb and speeds of 40 and 180 rpm in 80°F pH 7 water. Representative specimens of the various treatments were metallographically examined to determine the nature of the surface. In general, treated journals had much better wear resistance than untreated journals. The improvement was believed to be due mainly to surface oxidation. The best surface treatment consisted of Glas-shot blasting the surface followed by heating in air at 800°C for 21 hr. (auth)

965 (MSAR–68–135) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, April–June 1968. (MSA Research Corp., Evans City, Pa.). Sept. 1968. Contract AT(11-1)-765. 101p. (XAC–720264). Dep. CFSTI.

SODIUM—effects on mechanical properties of LMFBR candidate alloys at temperatures up to 1400°F, research program on

LOOPS—operating history of high-temperature sodium, for mechanical properties testing of LMFBR candidate alloys

STAINLESS STEEL—creep-rupture properties of Types 304 and 316, after exposure to high-oxygen sodium at 1200°F; corrosion of Types 304 and 316, by oxygen-contaminated sodium at 1200 and 1400°F; tensile properties of Types 304 and 316, after exposure to high-carbon sodium at 1200°F

SODIUM CHROMITES—formation in corrosion of stainless steels by oxygen-contaminated sodium at 1200°F

STEEL—tensile properties of ferritic, after exposure to helium and sodium at 1200°F

CHROMIUM ALLOYS SYSTEMS—Cr–Mo–steel, tensile properties after exposure to helium and sodium at 1200°F; Cr–Mo–steel–V, tensile properties after exposure to helium and sodium at 1200°F; Cr–Mo–steel–Ti, tensile properties after exposure to helium and sodium at 1200°F

CROLOY—tensile properties of 5 and 5-Ti, after exposure to helium and sodium at 1200°F

OXYGEN—determination in sodium loop, field testing of meters for

CARBON—determination in sodium loop, testing and calibration of meters for (D.L.C.)

966 (N–68–30000) HOT-SALT-STRESS-CORROSION CRACKING AND ITS EFFECT ON TENSILE PROPERTIES OF Ti–8Al–1Mo–1V TITANIUM-ALLOY SHEET. Royster, Dick M. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). Aug. 1968. 36p. (NASA-TN-D–4674). CFSTI.

The concluding phase of an extensive experimental investigation of hot-salt-stress corrosion of the Ti–8Al–1Mo–1V titanium alloy was conducted on self-stressed and tensile specimens of a 0.050 in. (1.3-mm) thick Ti–8Al–1Mo–1V titanium-alloy sheet (duplex annealed). The self-stressed specimens, with stresses of 50, 25, and 15 ksi, were dipped in a 3.4% NaCl solution and exposed at temperatures from 400 to 600°F for exposures up to 20,000 hours. Stress-corrosion cracking was obtained after approximately 17 hours at 600°F for the 50 ksi stress, but no stress-corrosion cracking was noted at 400°F at any stress level investigated. The threshold stresses decrease with an increase in exposure temperature and time. The tensile corrosion specimens were coated with a thin layer of salt (NaCl) and exposed at temperatures from 500 to 600°F at 50 ksi stress for exposures up to 800 hours to develop and grow stress-corrosion cracks. The presence of stress-corrosion cracks resulted in a large drop in elongation and a moderate decrease in tensile strength. The properties deteriorated more for the transverse specimens than for the longitudinal tensile specimens. The residual tensile properties appeared to be dependent only on the depth of the cracks, regardless of the temperature or time at which the cracks were developed. The stress-corrosion cracks were intergranular, and maximum crack depth could be correlated with exposure time at 550 and 600°F. (STAR)

967 (ORNL–4312) INTERACTIONS OF REFRACTORY METALS WITH ACTIVE GASES IN VACUA AND INERT GAS ENVIRONMENTS. Inouye, H. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 39p. Dep. CFSTI.

The state of our knowledge of the interactions of refractory metals with active gases in vacuum and inert gas environments is reviewed. At temperatures from 600 to 2000°C and at pressures from 10^{-3} to 10^{-10} torr, contamination, degassing, decarburization, and sublimation reactions occur between the refractory metals and absorbed gases. The extent and kinetics of these reactions are governed by the deviation of the interstitial concentration of the refractory alloy from the equilibrium concentration dictated by the temperature and pressure of the active gas. The reaction rates in inert gases are equivalent to vacua of approximately 10^{-5} to 10^{-7} torr. These interactions can be reduced by minimizing the surface-to-volume ratio of the metal and minimizing the degree of equilibrium disparity. Added control is gained by the use of barrier foil envelopes and the use of low-pressure CH_4 to neutralize the oxidizing gases. (auth)

968 STUDY OF ACTIVATION ENERGY DURING OXIDATION OF ZIRCONIUM AND ZIRCALOY-2. Sharan, R.; Ray, Narayan; Kalra, T. R. (Roorkee Univ., India). Univ. Roorkee Res. J., 9: No. 1-2, 7-16(1966).

Kinetics of oxidation of Zr and Zircaloy-2 at the reactor operating temperature and determination of the activation energies have been reported. An apparatus for the study of continuous oxidation has been set up and studies have been made at 550 to 800°C in the case of Zr and 550 to 900°C in the case of Zircaloy-2. Arrhenius equations have been used to calculate the activation energy. The slopes of the oxidation curves and curves Log K vs 1/T for both Zr and Zircaloy-2 were calculated by the least square method. The activation energy for Zr was found to be 15.189 k cal/mol at 550 to 800°C and for Zircaloy-2 to be 17.123 k cal/mol at 600 to 900°C. The mechanism for oxidation has been discussed briefly. (Indian Sci. Abstr.)

969 OXIDATION BY CO_2 GAS OF HIGH TENSION STEELS FOR GAS-COOLED POWER REACTORS. Ito, Goro; Ikeda, Seiichi Kinzoku Zairyo Gijutsu Kenkyusho Kenkyu Hokoku, 11: 115-22(Mar. 1968). (In Japanese).

Specimens of deposits, from heat affected zones and base metal were taken in the welds of high strength steels for CO_2 gas-cooled power reactors. Welding methods used include manual, CO_2-gas arc, submerged arc, and others. Oxidation tests were carried out in CO_2 at 400 to 600°C under pressure 10 kg/cm^2. It was found that no difference in the oxidation-resistance was observed in the high strength steels of 60 to 70 kg/mm^2. The amounts of oxidation were equivalent to 0.2 mm erosion per 20 years at 500°C, being well comparable with boiler steels. The oxidation was increased by flowing CO_2 gas, in comparison with the static gas. The addition of moisture to the gas caused the formation of blisters on the deposit surface. It is concluded that break-aways found are produced by the oxidation of metal exposed by a crack in the film, or by the selective oxidation where there exist P and S precipitations. (NSA of Japan)

970 OXIDATION OF ZIRCONIUM: A CRITICAL REVIEW OF LITERATURE. Rosa, C. J. (Univ. of Denver). J. Less-Common Metals, 16: 173-201(1968).

A compilation of past theoretical work in the field of zirconium oxidation is presented. The agreements and inconsistencies of results from different investigators are discussed. The different materials, oxidant purities, methods of specimen preparation, and techniques of following the oxidation kinetics employed by various investigators are noted. Experimental techniques commonly used and theoretical interpretations of the oxidation mechanism(s) are examined. (auth)

971 EFFECTS OF IRRADIATION ON THE OXIDATION OF ZIRCONIUM ALLOYS IN HIGH TEMPERATURE AQUEOUS ENVIRONMENTS. A REVIEW. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 28: 1-47 (Oct. 1968).

Experimental data on the effect of fission fragment, neutron and gamma irradiation on the oxidation of zirconium alloys are reviewed. It is shown that both fast neutron irradiation and the presence of free oxygen or oxidizing radiolytic species must be simultaneously present before any effect can be observed in high temperature water. In wager where the concentration of oxidizing species is low, specimens preautoclaved at 400°C show a larger acceleration of the oxidation rate than specimens pretreated at lower temperatures, or in the pickled condition. Hydrogen uptake is apparently largely independent of the oxidation process, and is also affected by the presence of oxidizing species, but to a different extent than the oxidation process. An hypothesis based on a shift in the balance between the electronic and ionic transport processes through the film during irradiation (due to the different sensitivity of the two processes to radiation and chemical conditions) is shown to explain the observations qualitatively. (auth)

972 DISLOCATION ETCH PITTING STUDIES ON TUNGSTEN SINGLE CRYSTALS UNDER POTENTIOSTATIC CONDITIONS. Maloof, S. R. (United-Carr, Inc., Watertown, Mass.). Corrosion, 24: 283-90(Sept. 1968).

Dislocation etch pitting of the (100) surface occurs in chloride as well as nitrate and sulfate solutions during anodic polarization in a well-defined potential range (+0.3 to +0.7V vs H_2) where the current is relatively insensitive to changes in potential. In chloride solutions, increasing the chloride ion concentration or temperature results in an increase in the rate of pitting. This suggests that the chloride ion participates in the pitting process. A linear current-time law is obtained at constant potential. A pitting rate curve established for the (100) surface in 0.5M NaCl is gaussian in shape with an apparent maximum at a potential of +0.48V. The potential at which the maximum occurs appears invariant with composition or temperature, suggesting that the same chemical species adsorbs on the surface prior to pitting. The decrease in the pitting rate above this potential is explained by the desorption of the chemical species, considered to be WO_2^{++}, as a result of further oxidation at more positive anode potentials to the species WO_4^{--}. The inability to etch pit the (110) surface under the same conditions is attributed to the direct formation of the doubly charged monotungstate ion WO_4^{--} during anodic dissolution and its subsequent adsorption at all positive anode potentials up to as high at 10V. The specificity of etch pitting solutions is explained in terms of a "critical" potential range for pitting. (auth)

973 MODIFICATION OF THE OXIDATION RATE OF METALS WITH ION-CONDUCTING COATINGS IN AN ELECTROCHEMICAL CHAIN. II. THE OXIDATION OF ZIRCONIUM. Eriksen, J. H.; Hauffe, K. (Univ., Goettingen, Ger.). Z. Phys. Chem. (Frankfurt), 59: 332-5(June 1968). (In German).

The modification of the oxidation rate of a scale system with ion-conducting coating by short-circuiting and imposition of an external electric field can be shown in the oxidation of zirconium. The time pattern of the oxidation of Zr with a Pt-covered ZrO_2 layer in oxygen at 1 atm at 800°C was measured with and without short-circuiting. The results showed that after cooling there is a rise of the oxidation rate even without short-circuiting, but with short-circuiting the increase is greater. The oxidation rate is also increased by local element formation. (J.S.R.)

974 THE EFFECT OF ENVIRONMENT ON CORROSION KINETICS, WITH PARTICULAR REFERENCE TO TEMPERATURE AND PRESSURE. Ullah, M. Z. London, Imperial Coll. of Science and Technology, 1968. 155p.

Thesis.

The aqueous corrosion of zirconium was studied as a function of various environmental conditions, e.g., temperature, pressure, hydrogen activity, and the solution pH. An autoclave was designed to permit measurements at temperatures above 100°C, and an optical method was used for recording the rate of corrosion. The experimental technique not only permitted control of various test conditions but allowed rates to be measured continuously during the reaction without removal of the specimen from its environment. The results emphasize the importance of the protective oxide film formed during corrosion. It was shown that hydrogen in some circumstances greatly increases the corrosion rate, and this is attributed to enhanced electronic conductivity and increased diffusion rates in the oxide. The results also showed that, if the growth of a film can be characterized by a sequence of rate laws, then the exponents calculated for all but the initial law will be liable to error unless the effect of the transition point coordinates is taken into consideration when interpreting data. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 513, 969, and 989.

975 LIQUID METAL-FUSED SALT PROCESS FOR THE PREPARATION OF REACTIVE METALS. Hariharan, A. V.; Subramanyan, R. B.; Paul, C. M. (Bhabha Atomic Research Centre, Trombay, India). pp 306-20 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A liquid metal-fused salt process for the preparation of reactive metals such as thorium, uranium, plutonium, and zirconium is described. The process is based on the reduction of the respective metal oxides in a molten halide flux medium by magnesium-zinc alloys. Pertinent thermodynamic and solubility data for these systems are presented. The process can be readily extended to other heavy metals including the rare earths. Process parameters like flux composition, magnesium concentration in the alloy phase, operating temperature and time, rate of agitation and oxide loading were examined in detail with respect to thorium and uranium and extended to plutonium. A scheme for the preparation of uranium metal by direct reduction of the ore concentrates is proposed on the basis of laboratory studies. The direct reduction of potassium zirconium fluoride and zirconium oxide by similar techniques was established to be feasible. The principal advantages of the process are substantial reduction in the number of steps involved in conventional flow-sheets and near quantitative reduction of the oxides (or fluorides) to metals and the attainment of high purity in the final metal. It can also be extended to the preparation of Mg-Th-Zn and Mg-Zr-Zn alloys that find applications in the aircraft industry. The process has potential value for the pyro-processing of irradiated nuclear fuels. (auth)

976 UNUSUAL WELD CRACKING PROBLEM IN INCONEL. Slaughter, G. M. (Oak Ridge National Lab., Tenn.); Franco-Ferreira, E. A.; Long, E. L. Jr.; Hallerman, G. Weld. J. (N. Y.), 47: 479s-80s(Oct. 1968).

Cracks were observed in several gas tungsten arc welds joining Inconel end caps to Inconel tubes in Inconel-sheathed fuel elements for the superheater assembly of the Puerto Rico Boiling Nuclear Superheat (BONUS) reactor. Defects were found to be in the Inconel tubes and end caps and not in the welds. It was found that an unusual set of conditions occurring in making circumferential welds of tube to end cap can produce unexpected concentrations of minor element contamination. In this case the grain boundary rivers showed phosphorous concentrations up to 5%. (F.S.)

977 WELDINGS PERFORMED FOR THE JAPC TOKAI POWER STATION. Takaichi, Toshio (Fuji Electric Co., Ltd., Japan). Haikan Gijutsu, 10: No. 6, 61-73(June 1968). (In Japanese).

The structures, materials, construction and inspections, for the JAPC Tokai power station, are described, from the viewpoint of welding. Careful preparation and rigid quality controls practiced in the construction of the power station, provide a source of useful information on building nuclear reactors. Discussions are included on tests and preparations prior to pressure vessel welding and on inspection, annealing, and pressure tests. Discussions are also included on welding stand-pipe nozzles, stand pipes, piping for damaged-fuel detection, and auxiliary CO_2 gas circuits. (NSA of Japan)

978 MACHINING OF THE MICRO STANDARD NOTCH OF THE REACTOR FUEL SHEATH TUBING BY THE IMPRESSION METHOD. Inagaki, Koji; Sugawara, Akira (Tohoku Univ., Sendai). Tohoku Daigaku Kagaku Keisoku Kenkyusho Hokoku, 16: 143-53(Nov. 1967). (In Japanese).

A method of non-destructive inspection of fuel cladding using machined micro notches is described. The machined precision depth of these notches is less than ±1.5 μ. (P.G.C.)

979 SIMPLE TECHNIQUE FOR THE PREPARATION OF PURE MANGANESE FOILS. Van Audenhove, J. (EURATOM, Geel, Belgium). Nucl. Instrum. Methods, 65: 115-16(Oct. 15, 1968).

A technique for the preparation of pure manganese foils, 0.05

to 0.3 mm thick and 150 mm², needed for nuclear measurements is described. The foils are electrodeposited on a stainless steel cathode, stripped and sandwich rolled. They can be retained for about 5 days at 20°C before volume-change associated with the transformation to the α-allotropic modification disrupts them. Foils stocked at −10°C could be kept flat and undamaged during more than 2 years. (auth)

980 CORROSION-RESISTANT HEATED TRANSFER TUBES FOR MOLTEN METALS AND SALTS. Grosvenor, D. E.; Winsch, I. O.; Miller, W. E.; Bernstein, G. J.; Pierce, R. D. (Argonne National Lab., Ill.). Nucl. Appl., 5: 329-32(Nov. 1968).

Pyrochemical processes under development at Argonne National Laboratory utilize molten metals and halide salts as solvents to separate molten fuel materials from each other and from fission products. These solvents are pressure-transferred between process vessels through resistance-heated transfer tubes operating at 850°C. The transfer tubes, J- or U-shaped, are fabricated from gun-drilled molybdenum-30 wt % tungsten bar stock and shaped by hot bending in a jig. A technique for joining two pieces of tubing was developed because the overall length of tubing that was available was limited. The transfer tubes are wrapped with controlled-voltage resistance heaters, covered with insulation, and protected by steel shells. (auth)

981 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Collins, Robert Dorrell (to United Kingdom Atomic Energy Authority). British Patent 1,131,480. Oct. 23, 1968. Filed Nov. 11, 1966.

Nuclear fuel elements are described in which uranium dioxide is encased in a protective sheath which houses an iodine trap comprising barium oxide. In one design, the sheath is completely sealed about the fuel and a trap utilized at the cooler end of the element. In a second design, the fuel element is vented and the gases released during operation are expelled into the surroundings along a vent path and a trap installed in the path. The third design utilizes fuel elements connected internally to a helium source and is continuously purged. Traps are provided to clean up the helium which is recirculated. (J.C.W.)

Properties Evaluations

Refer also to abstracts 965, 1011, 1057, 1544, and 1768.

982 (CEA-R-3473) AEROSOLS PRODUCED BY EVAPORATION OF A URANIUM WIRE. Morel, Colette (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar. 1968. 53p. (In French). Dep.

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, France.

The aerosols formed when a uranium wire is evaporated in a normal or rarefied atmosphere, either with or without a drying agent are investigated. The heating of the wire can be either fast or slow. Aerosol production apparatus and methods of measuring aerosols are discussed and the results obtained with various aerosols are described. The particles produced by the wire are found to be less than one micron. During rapid heating, the granulometric distribution of the aerosol obeys a log-normal law. During slow heating, the distribution has two modes: one near 0.05 μ, the other close to 0.01 μ. (auth)

983 (COO-972-12) MECHANICAL PROPERTIES OF SEPARATED METALLIC ISOTOPES. Final Report. Snyder, Donald D. (Andrews Univ., Berrien Springs, Mich.). Sept. 16, 1968. Contract AT(11-1)-972. 97p. Dep. CFSTI.

Mechanical properties of enriched isotopes of Li are determined. Measurements made include: bulk densities, the electrical resistivities, melting points, thermoelectric power, infrared absorption, the elastic modulus, and lattice spacing. Measurements were made for ^{6}Li, ^{7}Li, and natural Li. Procedures and results are described. (D.C.C.)

984 (CU-2660-32) HIGH TEMPERATURE THERMAL PROPERTIES OF GASES AND VAPORS. Progress Report, June 1966–March 1967. Bonilla, Charles F. (Columbia Univ., New York. Dept. of Chemical Engineering). Feb. 1967. Contract AT(30-1)-2660. 12p. Dep. CFSTI.

Additional data were obtained on the viscosity of cesium vapor up to 4 atm, and on the viscosity of rubidium and potassium. Also, the thermal conductivity of argon was determined up to 1100°C. Thermodynamic properties of alkali metals up to medium and high pressures are being studied. Errors in long sheathed thermocouples at high temperatures due to leakage currents among the thermocouple wires and the sheath were calculated along with resulting IR drops along the wires. A method was worked out for applying arbitrary weighting factors to all variables in a Least Squares Correlation involving up to 4 variables. (M.C.G.)

985 (GEMP-636) STRESS-RUPTURE PARAMETERS FOR THE REFRACTORY METALS. Conway, J. B. (General Electric Co., Cincinnati, Ohio. Missile and Space Div.). [1967]. 24p. (CONF-681004-3). Dep. CFSTI.

From 28th National Fall Conference of the American Society for Nondestructive Testing, Detroit, Mich.

Studies have identified the creep-rupture behavior of various refractory metals to temperatures as high as 3000°C. Data have been generated for W, Re, Mo, Ta, and Nb as well as for W-25Re, Mo-50Re, and Ta-10W. These results have been used in some fairly extensive correlations based on the Larson-Miller, Dorn, and Manson-Haferd parameters. In a detailed study of the W, Mo, and W-25Re data in the temperature range 1200 to 3000°C, the Manson-Haferd parameter was found to yield the most effective representation of the stress-rupture data. In another correlation based on the Larson-Miller parameter, homologous temperatures were employed to show identical correlations for the tungsten and molybdenum stress-rupture data. Using optimization procedures Larson-Miller constants were calculated for various refractory metals and refractory metal alloys. These constants were found to vary from 5.7 for a ternary W−Re−Mo alloy to about 10 for Ta-10W and about 20 for Mo−TZM. Garofalo-type correlations in which the Larson-Miller and Dorn parameters for several refractory metals are expressed as hyperbolic sine functions of the stress are discussed. A summary is included. (auth)

986 (N-68-29992) GENERATION OF LONG-TIME CREEP DATA OF REFRACTORY ALLOYS AT ELEVATED TEMPERATURES. Sawyer, J. C.; Steigerwald, E. A. (TRW Equipment Labs., Cleveland, Ohio). Aug. 1968. Contract NAS3-2545. 197p. (NASA-CR-1115; TRW-ER-7203). CFSTI.

Creep tests were conducted on selected refractory alloys in a vacuum environment for times between 100 and 15,000 hours. Since the ultimate program goal was to provide design data for space electric power systems, particular emphasis was placed on measuring creep extension below 1%. The resulting data were evaluated in terms of the relative properties of niobium, molybdenum, tantalum, and tungsten-base alloys. In the 1800 to 2200°F temperature range, the molybdenum-base alloys TZC and TZM possess the best creep properties for potential turbine applications. The variability of the creep properties as a function of heat of material was determined for the T−111 alloy. In addition to comparison of alloy creep properties, chemical analysis, metallography, and tensile test data are presented to characterize each of the materials before and after creep testing. (STAR)

987 (N-68-30605) SUPERPLASTICITY IN TUNGSTEN–RHENIUM ALLOYS. Garfinkle, M.; Witzke, W. R.; Klopp, W. D. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1968. 22p. (NASA-TN-D-4728). CFSTI.

Electron beam melted tungsten−rhenium alloys containing 20 to 28 atomic percent Re exhibited elongations of over 200 percent in tensile tests at 3630°F. Rapid grain growth rates in these alloys, relative to tungsten−rhenium alloys with lesser Re contents, and continuous recrystallization during tensile testing indicate the occurrence of enhanced diffusion processes. Strain rate sensitivities generally ranged between 0.2 and 0.3 for these alloys, but strain rate sensitivities as high as 0.8 were observed under the special conditions encountered immediately following initial recrystallization. These were well within the range associated with superplastic materials. (STAR)

988 PROPERTIES OF POWDER METALLURGY WEAR RESISTANT ALLOYS. Carlsen, F. L., Jr.; Dreyer, D. G. (Union Carbide Corp., Kokomo, Ind.). Int. J. Powder Met., 4: No. 4, 31-7(Oct. 1968).

The properties of five wear-resistant alloys made by powder metallurgy techniques are compared with those made by conventional melting and casting. The alloys concerned were three cobalt-base compositions, one nickel-, and one iron-base alloy. The micro-structures of the powder metallurgy products were much more uniform, but had up to three percent porosity. The hardness values were comparable, while the tensile properties of the powder metallurgy products were generally better. (auth)

989 EFFECTS OF FABRICATION THERMAL HISTORY ON THE PROPERTIES OF NUCLEAR VESSEL STEELS. Ando, Yoshio; Iida, Kunihiro (Tokyo Univ.). Nucl. Eng. Design, 8: 143-61(1968).

During construction of a reactor steel pressure vessel, the material may be subjected to thermal treatments which have serious effects on the quality of the material. Results of studies

carried out to investigate the effect of various fabrication thermal histories on brittle, ductile, and fatigue fracture properties of A302B steel and its welds are reported. Through a proper thermal history consisting of treatment for hot forming, quench and tempering, stress relief annealing at 625°C, deterioration of materials in the final state of thermal treatment can be prevented. (auth)

990 DIFFUSION OF MOLYBDENUM IN ZIRCONIUM. Agarwala, R. P.; Paul, A. R. (Bhabha Atomic Research Centre, Trombay, India). pp 542-8 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

Using the residual activity technique, lattice diffusion of molybdenum in alpha- and beta-zirconium was studied. The diffusivities (in cm^2/sec) are expressed as: $D_{Mo/Zr}\ (\alpha) = 6.22 \times 10^{-8} \exp(-24.760/RT)$ and $D_{Mo/Zr}\ (\beta) = 2.63 \exp(-68.550/RT) + 1.991 \times 10^{-4} \exp(-35.200/RT)$. In the alpha phase, diffusion seems to take place through dislocation pipes while in the beta phase, plots of log D vs 1/T show a curvature at temperatures higher than 1100°C. The curvature was analyzed for high-temperature enhancement of diffusivities. These were represented in the beta phase equation in a composite form. The possible mechanism of diffusion and the difficulties associated with each mechanism are discussed to explain the results. (auth)

991 HEAVY SECTION STEEL TECHNOLOGY PROGRAM: AN ENGINEERING INVESTIGATION OF THE STRUCTURAL BEHAVIOR OF THICK PRESSURE VESSELS. Witt, F. J. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Design, 8: 22-38(1968).

The structural behavior of the thick section plates and pressure vessels fabricated from such plates for use in light water power reactor systems was investigated. The major emphasis is on the effects of flaws and material inhomogeneities and discontinuities under in-service reactor operating and accident conditions. The fracture modes of these vessels are of special interest because of the dangers peculiar to nuclear reactors should a major failure of a pressure vessel occur while in service. The program is being carried out in very close cooperation with the materials, fabrication, and design interests of the United States nuclear power industry. The scope of the program is outlined and the objectives of the various tasks are identified. Results obtained during the initial efforts of the program are presented. (auth)

992 SURFACE TENSION AND DENSITY OF THE LIQUID EARTH ALKALINE METALS Mg, Ca, Sr, Ba. Bohdansky, J.; Schins, H. E. J. (CCR-EURATOM, Ispra, Italy). J. Inorg. Nucl. Chem., 30: 2331-7(Sept. 1968).

The surface tensions and the densities of Ba, Ca, Mg, and Sr were determined in a region of high temperature. The method used is described in J. Inorg. Nucl. Chem., 29: 2173(1967). Discrepancies in temperature dependences and absolute values with regard to existing data were found. The measurements correspond to the following formulas: Mg: $\sigma = 721 - 0.149T$, ρ = Earlier data confirmed; Ca: $\sigma = 472 - 0.100T$, $\rho = 1.613 - 2.21\ 10^{-4}T$; Sr: $\sigma = 392 - 0.085T$, $\rho = 2.648 - 2.62\ 10^{-4}T$; and Ba: $\sigma = 351 - 0.075T$, $\rho = 3.59 - 2.74\ 10^{-4}T$. The intersection of all surface tension lines in one point near $\sigma = 0$ is interpreted as a consequence of equal surface energy per surface atom for all alkaline earths. (auth) (UK)

993 STRUCTURAL EFFECTS ON STRESS RUPTURE AND SUPERPLASTICITY BEHAVIOR IN Co-W ALLOYS. Vishnevsky, Constantine. Cleveland, Case Western Reserve Univ., 1967. 116p.

Thesis.

Stress rupture tests of four Co-W base alloys were conducted at 1800 and 1850°F in air. As cast specimens produced in conventional investment molds and by unidirectional solidification were tested. These alloys were also extruded to investigate the properties of hot worked structures. Variable strain rate tests of extruded Co-45W-0.05Zr (wt %) at 1800°F were employed in a study of superplasticity. The influence of unidirectional solidification on the rupture life and ductility was determined by the alignment of grain boundaries competing with the geometry, orientation, and distribution of second phases. The ductility was increased for all but modified Co-45W. Rupture life after unidirectional solidification was higher for Co-45W-0.05Zr but lower for modified Co-35W. In Co-45W-0.05Zr and modified Co-45W, rupture life was greater for the unidirectional structure at low stresses only. Extruded Co-35W-0.05Zr and Co-45W-0.05Zr experienced a nearly 100 fold degradation in rupture life but large increase in ductility. The existence of superplasticity in extruded Co-45W-0.05Zr was established. The necessity of a fine structure for superplasticity was demonstrated; the role of phase transformation was secondary. Continued recrystallization or grain boundary migration during deformation was suggested by microstructural evidence. (Disser. Abstr.)

994 PLATINUM METAL ALLOYS FOR THE MEASUREMENT OF STRAINS AT HIGH TEMPERATURE. Bertodo, R. (Ruston and Hornsby, Ltd., London). Engelhard Ind., Tech. Bull., 9: 37-49(Sept. 1968).

Measurement of steady strains up to 1000°C is investigated. Essentially satisfactory gages exist for use up to 300°C. At 300 to 1000°C alloys of platinum and tungsten are shown to be marginally acceptable in strain gage elements. Work on platinum metals and their alloys is reviewed and the behavior of platinum metals and alloys exposed to oxidizing atmospheres for extended periods of time is examined. Recent work aimed at obtaining more satisfactory alloys for use at extreme temperatures is outlined. It is concluded that the behavior of platinum-tungsten alloys is dependent upon their metallurgical state. This leads to limitations where extended exposure to adverse environments is encountered. On the basis of limited test results, an alloy of platinum, palladium, and molybdenum is shown to be superior to other alloys for steady strain element manufacture. (auth)

995 ISOTHERMAL PHASE DIAGRAM OF Nb-Zr-Ti TERNARY SYSTEM AT 570°C (SUPPLEMENT). Doi, Toshio; Kitada, Masahiro; Ishida, Fumihiko (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 684-5(1968). (In Japanese).

A modified isothermal phase diagram of the Nb-Zr-Ti ternary system at 570°C is presented. In this new phase diagram, a new $\alpha_{Zr} + \beta' + \beta''$ phase region is added and the diagram at 570°C consists in the following eight phase regions; α_{Zr}, $\alpha_{Zr} + \beta'$, $\alpha_{Zr} + \beta''$, $\alpha_{Zr} + \beta' + \beta''$, $\beta' + \beta''$, β, $\alpha_{Ti} + \beta$ and α_{Ti}. (auth)

996 EFFECT OF CHROMIUM CONTENTS ON THE ISOTHERMAL TEMPERING CHARACTERISTICS OF 3 Mo-Cr TYPE STEELS. Nishimura, Tomitaka (Japan Special Steel Co. Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 32: 708-13(1968). (In Japanese).

The changes in hardness, tensile properties, electrical resistivity, lattice parameter of matrix, carbide reaction, and electron microstructure of 0.3 C-3 Mo-Cr type steels containing 2 to 12% Cr when isothermally tempered in the temperature range of 400 to 700°C up to 1000 hr are reviewed. The results obtained were plotted against the tempering parameter $P = T\ (20 + \log t) \times 10^{-3}$, and discussed. In higher Cr steels, the peak of hardness shifts to the lower parameter side. In the process of softening an abnormal change occurs, and the elongation and reduction of area decrease suddenly. The electrical resistivity and lattice parameter of matrix decrease with increase in the tempering parameter, and show larger values in higher Cr steels. On isothermal tempering, the following reaction in carbides takes place: $Fe_3C \rightarrow M_2C \rightarrow M_7C_3 + M_6C$ for 2% Cr steel, and $Fe_3C \rightarrow M_2C \rightarrow M_{23}C_6 + M_6C$ for 5 to 12% Cr steels. In higher Cr steels, iron carbide transforms more rapidly to alloy carbide, and the rate of growth and the agglomeration of alloy carbide becomes smaller. (auth)

997 DIFFUSION LAYERS BETWEEN CARBON STEELS AND CEMENTED CARBIDES CONTAINING TANTALUM OR TITANIUM CARBIDE. Suzuki, Hisashi; Yamamoto, Takaharu; Kawakatsu, Ichiro (Tokyo Univ.). Nippon Kinzoku Gakkaishi, 32: 721-5(1968). (In Japanese).

The addition of tantalum or titanium carbide to WC-Co cemented carbide has been known to depress the cratering wear on the carbide tools during cutting steel. In order to obtain some fundamental information on this cause, carbon steels and three-phase cemented carbides containing tantalum or titanium carbide were mutually welded at 1250°C for 1 hr, and the diffusion layers were examined. The characteristics of the diffusion layers developed between carbon steels and cemented carbide specimens were the same as those between carbon steels and WC-Co straight alloys. The structure of the layers was strongly affected by the carbon content of each coupling material, and the M_6C type compound was formed only when the low carbon cemented carbides were coupled with low carbon steels. Tantalum carbide and β phases were stable in the diffusion layers, and these carbides checked not only the diffusing amount of cobalt and iron but also the formation of the M_6C type compound. The formation of the complex carbide was suppressed by titanium carbide addition. Tantalum carbide and β phases in cemented carbides changed their carbon contents according to the inter-diffusion of carbon, suggesting that these carbides acted as sinks or sources of carbon. Thus, it was considered that this mechanism was closely related to the suppressing effect of carbide addition on the formation of the complex carbide or in practice on the cratering wear of carbide tools. Titanium carbide is a more effective reducer of cratering wear than tantalum carbide. (auth)

998 A STUDY ON RUPTURE PROPERTIES OF LARGE WELDED SPECIMENS OF HT70 STEEL FOR NUCLEAR PRESSURE VESSELS. IV. SOME DISCUSSIONS ON CREEP RUPTURE CONFIGURATION. Okane, Isao; Inagaki, Michio (National Re-

search Inst. for Metals, Tokyo). Yosetsu Gakkaishi, 37: 678-82 (Sept. 1968). (In Japanese).

The difference in rupture configuration between large and small size welded specimens, and welding methods viewed from creep rupture configuration are discussed. The large size welded specimens are ruptured at the heat affected zone of base metal (HAZ) near the bond, while the small size welded specimens are ruptured at HAZ near the base metal. The plate thickness of the steel used is 30 mm, and the welded joints are made by multi-layer welding. Therefore, it may be considered that the properties at welded joint of specimens of both sizes are different. It is clear from the foregoing that creep strength may be proportionate to the absorbed energy to rupture in a high temperature tensile test. Tensile tests at 450°C on synthetic HAZ specimens, with respect to the coarse grain part near bond and the fine grain part near base metal in HAZ of small size welded specimens, were carried out to measure the absorbed energy. The value of absorbed energy in fine grain part is less than that in coarse grain part. Consequently, it may be considered that small size welded specimens are ruptured at fine grain part of HAZ near base metal, while large size welded specimens are ruptured at coarse grain part of HAZ near bond. (NSA of Japan)

999 INTERNAL FRICTION IN GADOLINIUM. Burdett, C. F. (Univ. of Strathclyde, Glasgow). Phil. Mag., 18: 745-52(Oct. 1968).

The low-temperature internal friction spectrum of gadolinium consists of two peaks, labeled α and β. The former is independent of, and the latter dependent on, the strain amplitude. Domain wall motion, induced by the applied stress, is responsible for both peaks, which are not caused by a relaxation mechanism. The microeddy currents generated by changes in magnetization are responsible for the α peak, and from an analysis of the theory, a domain size of 10^{-3} cm is deduced. The β peak is caused by the temperature variation of the magnetostriction constant and is essentially a hysteresis loss. (auth) (UK)

1000 EFFECTS OF SURFACE OXIDATION UPON THE TENSILE CREEP BEHAVIOR OF α-URANIUM. Kench, J. R.; Chamberlain, J. (English Electric Co. Ltd., Whetstone, Eng.). J. Nucl. Mater., 28: 61-72(Oct. 1968).

An analysis of the creep behavior of α-uranium polycrystals at low applied stresses indicates that internal stresses of the order of 600 psi may be present in the specimens. Experiments are reported which demonstrate that the cause of the internal stress is surface oxidation; a simple model is used to predict that the compressive yield stress of a coherent oxide film is of the order of 280,000 psi, and it is suggested that this high value may be related to elastic fracture during formation. Differences in behavior between γ-quenched, and β-quenched samples are traced to inherent differences in precipitate distribution and grain size. (auth)

1001 MEASUREMENT OF THE COEFFICIENT OF DIFFUSION OF CARBON IN RHENIUM. Ducros, Robert; Le Goff, Pierre (CNRS, Nancy). Compt. Rend., Ser. C, 267: 704-6 (Sept. 16, 1968). (In French).

Measurement was made by a continuous process by mass spectrometry of the speed of formation of carbon monoxide when a previously carbureted ribbon of rhenium was heated in the range 1500 to 2000°K in the presence of oxygen, the diffusion of carbon in rhenium being the limiting process. It was thus determined that: $D = (0.1 \pm 0.04) \exp - (53000 \pm 5000/RT)$ $cm^2 \cdot sec^{-1}$. (tr-auth)

1002 THERMAL EXPANSION OF TUNGSTEN MONOCARBIDE. Deshpande, V. T.; Pawar, R. R.; Suryanarayana, S. V. (Osmania Univ., Hyderabad, India). Curr. Sci. (India), 37: 543-5(Oct. 5, 1968).

A review of available data on the thermal expansion of WC is given. Experiments were performed taking X-ray powder pictures of WC at different temperatures employing a high temperature symmetrical focusing camera and CuK x radiation. Lattice parameters were evaluated and compared with previous results. A listing of 20 references is included. (J.C.W.)

Structure and Phase Studies

Refer also to abstract 1000.

1003 CLUSTERING IN Al-Be 0.1 PERCENT ALLOY. Ceresara, S.; Federighi, T.; Fiorini, P. (ISML, Novara, Italy). Phil. Mag., 18: 49-54(July 1968).

Results of a resistometric investigation on an Al-Be 0.1% alloy showed that G.P. zone formation takes place in this alloy, during aging after quenching, in a wide temperature range. The process is characterized by the existence of an interaction energy between vacancies and zones and by a remarkable stability of zones. Results also indicate the existence of an interaction energy between vacancies and Be atoms. (auth) (UK)

1004 FORMATION OF THE σ PHASE IN THE W-Re SYSTEM. Waldhauser, Ilona. Hiradastechnika, 19: 215-220(July 1968). (In Hungarian).

Tests were conducted to establish the limit to which the solubility of rhenium in tungsten and that of tungsten in rhenium extends, and the boundaries of the extremely brittle intermetallic phases that prevent the industrial use of the alloys. In addition, factors that effect the solubilities and the development of intermetallic phases—especially impurities—were investigated. It was established that the effects of heat treatments are of particular significance in the formation of the intermetallic phases in general and of the σ phase in particular. Further research is necessary before the W-Re alloys can be effectively used in the communications technological industry. (JPRS)

1005 FIELD ION MICROSCOPE INVESTIGATION OF THE TUNGSTEN-RHENIUM-OXYGEN SYSTEM. Novick, David Theodore. New York, Columbia Univ., 1968. 76p.

Thesis.

Bright spots, appearing in field ion micrographs of pure tungsten and alloys of W with 1¼% and 3% Re, found in a triangular region defined by the [011], [121], and [112] poles were studied as a function of oxidation treatment and Re concentration. The concentration of these bright spots is found to increase in all three materials as a result of oxidation, the relative increase being the same in all cases. Additionally, the concentration of bright spots increases proportionally to the Re concentration independent of the treatment. The simplest interpretation for these observations is that the bright spots are due to oxygen in interstitial solid solution. Tests on the data indicate that the Re bearing alloys contain Re-O clusters which obey the Mass Action Law and that the solubility of O at defect free sites adjacent to W atoms alone, is unaffected by the presence of Re in solution. Data are used to determine a binding free energy (1.04 eV at 2100°C) for the Re-O complex. This value and the above conclusions are utilized to suggest that the "Re effect" in Group VIA transition metals is probably due to a partial equilibrium for interstitial solute at sites adjacent to Re atoms and sites adjacent to defects, such as dislocations and grain boundaries, with the equilibrium being heavily weighted in favor of the former because of the high binding free energy. In short, the Re acts to scavenge interstitial solute from sites at defects. (Disser. Abstr.)

1006 PHASE EQUILIBRIA IN THE Ni-Al-Y SYSTEM AT 1000°C. Rosen, S.; Goebel, T. A. (Pratt and Whitney Aircraft, Middletown, Conn.). J. Less-Common Metals, 16: 285-7(1968).

The nickel-rich region of the Al-Ni-Y ternary system has been investigated at 1000°C. Twenty-seven ternary alloys were prepared of which all but two contained greater than 50 at. % Ni. Emphasis was placed on the identification of solid phase equilibria based on an analysis of equilibrated alloy specimens. As a result of this study, a portion of the 1000°C isothermal section of the Al-Ni-Y ternary phase diagram has been constructed. (auth)

1007 F.I.M. IMAGING OF SOLUTE ATOMS IN DILUTE BINARY ALLOYS. Dubroff, W.; Machlin, E. S. (Columbia Univ., New York). Acta Met., 16: 1313-23(Nov. 1968).

Field Ion Microscopy (F.I.M.) observations of the completely imaged (102) plane of dilute Pt base alloys (W-, Pd-, Co-, Ni-, Au-Pt) have been made. Bright spot concentration equal to the solute concentration was found in the W-Pt system. Vacant site concentrations equal to the solute concentrations were found for the other systems above 2 at. % nominal solute concentration. On the basis of these observations it was concluded that the bright spots and vacant sites represented the lattice sites of solute atoms in the corresponding binary solid solutions. At and below 2 at. % nominal solute concentration, the vacant site concentration exceeded the solute concentration by about 1 at. %. This discrepancy was not resolved in the present investigation. It was found that solute clustered in the Au-Pt system and ordered in the W-Pt system. Relative to the random distribution more solute-solute pairs are found in the Au-Pt system and less such pairs are found in the other systems studied. It was concluded that a quantitative measurement of short range order in dilute Pt-base binary alloys by means of such F.I.M. observations is feasible. (auth)

Radiation Effects

Refer also to abstract 971.

1008 (BMI-1845, Sect. B) RADIATION EFFECTS ON FAST-REACTOR CLADDING AND STRUCTURAL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 22p.

Tensile testing of irradiated Type 347 stainless steel specimens at elevated temperatures continued. The specimens were annealed for 1 hr at 980°C before testing. Loss of ductility and increase in yield strength occur at about the same testing temperature. Metallographic examinations were performed on unirradiated specimens and irradiated and annealed specimens tested at various temperatures. In an attempt to determine whether the embrittlement phenomenon in irradiated stainless steel at elevated temperatures is dependent on diffusion; tensile tests were performed at 650°C on irradiated stainless steel utilizing different holding times at the testing temperature before the tensile test was started. Stress-rupture tests at 650°C were performed on Type 347 stainless steel and irradiated to a fast fluence of 2.2×10^{22} mvt. Annealing of the Type 347 stainless steel at high temperatures resulted in density changes when the annealing temperatures were high. An emission spectrographic analysis was performed on an irradiated Type 347 stainless steel specimen. Tensile tests were performed on irradiated specimens of Nickel 200, Tenelon, UMCo-50, and Haynes Stellite 25. Radiation-induced elevated-temperature embrittlement in stainless steels occurs by intergranular fracture. Attempts were made to grow single crystals (no grain boundaries) of Type 347 stainless steel by electron-beam zone melting and controlled solidification. A capsule containing 64 specimens was constructed. Tensile specimens and fatigue and tubular specimens of Type 347 stainless steel were loaded in the EBR-II. Specimens of Tenelon, UMCo-50, and Haynes Stellite 25 were loaded in the EBR-II to study the effect of nickel on irradiation-induced embrittlement. Sheet samples of Type 347 stainless steel were prepared and irradiated to determine the radiation-induced changes in tensile properties. The fracture toughness of the PM-2A pressure vessel was determined at −20°F from WOL wedge-opening-loading specimens from various locations in the vessel. (J.C.W.)

1009 (N-68-28818) EFFECT OF 10^{20} NEUTRON PER SQUARE CENTIMETER IRRADIATION ON EMBRITTLEMENT OF POLYCRYSTALLINE TUNGSTEN. Younger, Charles L.; Wrights, Gilbert N. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1968. 59p. (NSAS-TM-D-4661). CFSTI.

The effect of reactor irradiation on embrittlement of polycrystalline tungsten was investigated by comparing ductile-to-brittle transition of unirradiated and irradiated material. Tensile tests were conducted in the range 300 to 700°F. Bend tests, conducted at room temperature, provided additional data. Test results show that recrystallized tungsten irradiated with 1×10^{20} fast neutrons per cm^2 is severely embrittled. The ductile-to-brittle transition temperature for the irradiated material increased by at least 300°F, accompanied by an increase in the temperature-dependent yield point stress and decreases in the tensile fracture and extreme fiber bending stresses. The embrittlement appears to be a result of factors which decrease grain boundary strength and inhibit transgranular fracture. Also determined were irradiation effects on specimen dimensions, density, and electrical resistivity. Dimensional and density changes were small, but the electric resistivity increased linearly with increasing irradiation and reached 87% at the highest irradiation exposure. It may be concluded that irradiation of unalloyed, polycrystalline tungsten with 10^{20} fast neutrons per cm^2 and 10^{21} thermal neutrons per cm^2 produces a very brittle tungsten—1-percent-rhenium alloy with strength greater than that of the starting material, but because of irradiation-induced point defects, dislocation loops, and defect clusters, the grain boundary strength is decreased. (STAR)

1010 (RD/B/N-1179) OBSERVATION OF IMPURITY SEGREGATION WITHIN AN ARRAY OF PARALLEL DISLOCATIONS. Buswell, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sept. 1968. 9p. Dep. UK.

A field ion microscope study was made of an array of parallel dislocations, of mixed edge and screw character, in W. In the particular specimen studied, which had been irradiated to a fast neutron dose of 5.42×10^5 n/m^2 at 40°C, evidence was found for the segregation of impurities along the dislocation lines and in the plane between the dislocations. The observation is correlated with electron microscope evidence for the presence of such dislocation arrays in W. (auth) (UK)

1011 RADIATION EMBRITTLEMENT OF REACTOR VESSEL STEELS AND SUGGESTIONS FOR ITS CONTROL. Steele, L. E.; Potapovs, U. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 8: 58-70(1968).

The potential for neutron embrittlement of reactor pressure vessel steels as well as for the control of embrittlement or its consequences are reviewed. Operational procedures including the control of stress-temperature relationships or the use of heat treatment techniques for ductility restoration are shown to offer good potential for operating nuclear plants. Design procedures including higher temperature, greater vessel shielding, careful selection of, or the development of, radiation insensitive steels are available to minimize radiation embrittlement in reactor vessels of the future. Progress toward producing radiation insensitivity in current and higher strength versions of US pressure vessel steels is reviewed briefly. (auth)

1012 EFFECTS OF COUPLING NUCLEAR RADIATION WITH STATIC SERVICE STRESSES ON PRESSURE VESSEL MATERIAL BEHAVIOR. Hawthorne, J. R.; Loss, F. J. (Naval Research Lab., Washington, D. C.). Nucl. Eng. Design, 8: 108-16(1968).

The nuclear service performance of two pressure vessel steels as influenced by the application of static stress during radiation exposure has been examined. Bar samples from an A350-LF1 (Modified) steel forging and from a heavy section A302-B steel plate were irradiated under uniaxial tension at 430 and 550°F, respectively, together with unstressed (reference) specimens for comparisons of Charpy-V notch ductility performance. Applied stress levels were in excess of 75% of individual steel yield strengths at temperature. A brief description of the special exposure assembly and control instrumentation is presented. Experimental data for both steels suggest no synergistic effect of applied stress and radiation on mechanical properties performance under conditions simulating nuclear service. The post-irradiation annealing response of the low alloy A302-B steel also was not found to be influenced by stress during irradiation. (auth)

1013 THE INFLUENCE OF NIOBIUM IN IRRADIATION STRENGTHENING OF DILUTE Zr–Nb ALLOYS. Williams, C. D.; Ells, C. E. (Chalk River Nuclear Labs., Ontario). Phil. Mag., 18: 763-72(Oct. 1968).

The irradiation damage configuration and yield stress response obtained in the c.p.h. α' and α phases in a Zr-2.7% Nb alloy after fast-neutron irradiation were studied as a function of pre-irradiation solute distribution. Largest yield stress increments were obtained for specimens irradiated with the solute initially in metastable solution, pre-irradiation ageing treatments reducing the yield stress response. Electron microscope studies showed that the irradiation damage configuration was also determined by the solute super-saturation in the alloy phases, maximum strengthening being associated with a population of defect clusters or loops of <30 Å diameter. A mechanism for the defect stabilization is proposed. (auth) (UK)

1014 STORED ENERGY IN NEUTRON-IRRADIATED METALS. Pedchenko, K. S.; Karasev, V. S. (Kiev Inst. of Physics). Fiz.-Khim. Mekh. Mater., 4: 453-8(1968). (In Russian).

Release of stored energy was studied using metals bombarded with fast neutrons. Cylindrical specimens of 99.99% Cu and 99.9% Mo polycrystals preliminarily annealed in a vacuum at 450 and 1100°C, respectively, were irradiated with up to 2×10^{20} n/cm^2 (E = 1 MeV) in a VVR–M reactor. The integral magnitudes of released energies were used for evaluating the concentration of radioinduced defects. Data obtained from temperature spectral analysis revealed the kinetic characteristics and recovery mechanisms. (R.V.J.)

1015 INFLUENCE OF NEUTRON SPECTRA ON THE STRENGTH OF IRRADIATED STEEL. Krasnoshchekov, M. M.; Markovskii, E. A. (Kiev Inst. of Problems in Casting). Fiz.-Khim. Mekh. Mater., 4: 463-6(1968). (In Russian).

Radiation effects on mechanical properties of metals were studied with steel-45 and Armco-iron irradiated in a nuclear reactor. Data obtained showed that fast-neutron irradiation improved the strength and wear resistance of the examined materials. A temporary softening of the material during irradiation was due to the effects produced by thermal neutrons. It was also found that the most effective improvement of Armco-iron began with the fast neutron flux of 10^{18} n/cm^2. The strengthening of Armco-iron specimens was higher than that in steel-45. Generally irradiation with mixed neutrons worsened mechanical properties of the specimens and irradiation with fast neutrons improved them. (R.V.J.)

1016 IGNITION OF IRRADIATED URANIUM. Fischer, D. F.; Schnizlein, J. G. (Argonne National Lab., Ill.). J. Nucl. Mater., 28: 124-8(Oct. 1968).

The ignition temperatures of U specimens irradiated to burnup in O_2 were lower than those of unirradiated U. Irradiated samples ignited at 400°C, to a burnup of 0.79% U-235, and at 350°C for a burnup of 1.71%. Unirradiated control samples ignited at 600°C. Behavior of irradiated U in air was more complex. (P.G.C.)

1017 SMALL-ANGLE X-RAY SCATTERING FROM VOIDS PRODUCED IN HIGH-PURITY NICKEL DURING NEUTRON IRRADIATION. Kissinger, H. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 28: 118-19(Oct. 1968).

Inhomogeneities introduced by voids, resulting from fast neutron

irradiation of Ni, produced X-ray diffraction effects at very low angles. The scattering effect was used to estimate void diameter and concentration. (P.G.C.)

1018 VOIDS PRODUCED IN HIGH PURITY NICKEL BY NEUTRON IRRADIATION. Mastel, B.; Brimhall, J. L. (Pacific Northwest Lab., Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 28: 115-17(Oct. 1968).

The mechanisms involved in the formation of gas-free voids in high-purity Ni foils by fast neutron irradiation are described. (P.G.C.)

Ceramics and Cermets

Refer also to abstracts 962, 963, and 1991.

1019 (BMI-1845) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY 1967-JUNE 1968. Annual Report. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). July 1, 1968. Contract W-7405-eng-92. 69p. Dep. CFSTI.

Three papers on the characterization, development, and preparation of plutonium-nitride fuels and ceramic-coated particle fuels and radiation effects on fast-reactor cladding and structural materials for LMFBR applications are presented. Separate abstracts are prepared for three. (J.C.W.)

For abstracts of individual sections see: 1008, 1034, and 1035.

1020 (IS-1900, Paper 1) CERAMIC AND MECHANICAL ENGINEERING DIVISION. Spedding, F. H.; Wilder, D. R.; Fisher, R. W.; Hunter, O. (Ames Lab., Iowa). 21p.

Research progress is reported on O_2 diffusion in rare earth oxides, stabilization and thermal properties of rare earth oxides, emittance of rare earth oxides and uranium oxide, and sintering of samples composed of As-S-Se. Research results are also reported on liquid Na corrosion of Inconel, properties of Ucr eutectics, corrosion of Y by liquid U, and electromagnetic pump performance. (J.R.D.)

1021 CERAMIC MICROSTRUCTURES. THEIR ANALYSIS, SIGNIFICANCE, AND PRODUCTION. Proceedings of the Third International Materials Symposium, held at the University of California, Berkeley, June 13-16, 1966. Fulrath, Richard M.; Pask, Joseph A. (eds.). Inorganic Materials Research Division Series. New York, John Wiley and Sons, Inc., 1968. 1023p. $29.95. (CONF-660619).

A total of 45 papers were presented at the symposium. Eighteen of these papers were in NSA scope, four having been previously abstracted in NSA as 21: 28778, 21: 14917, 20: 46191 and 20: 33258. A separate abstract was prepared for each of fourteen papers. Papers for which no abstracts were prepared are concerned with random microstructures, computer applications, sample preparation, grain boundaries, surfaces, spectrometry, solid solutions, mechanical properties, electric properties, porosity and gas diffusion, phase distribution, density, and MgO crystals. (P.G.C.)

For abstracts of individual papers see: 1030-1032, 1039-1044, and 1059-1063.

Preparation and Fabrication

Refer also to abstract 2134.

1022 (ORNL-4311) SOL-GEL THORIA EXTRUSION. Fitts, R. B.; Moore, H. G.; Olsen, A. R.; Sease, J. D. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 31p. Dep. CFSTI.

The sol-gel process provides a stable colloidal suspension of various ceramic materials. This suspension, or sol, may be concentrated, dried, and fired at low temperatures to form dense ceramic bodies. Standard ceramic equipment and the concentrated sol, or clay, with powder additions to extrude pure oxide ceramic bodies of various shapes and controlled density are used. The extrusion blend requires no extraneous binders or plasticizers. It was demonstrated in laboratory-scale work that this process produces high-strength solid and cored extrusions of thoria fired at 1150°C with controlled densities ranging from 70 to 99% of theoretical and with diameters up to ½ in. (±0.001 in.) and lengths to 3 in. The effects of various powder additions and drying conditions on extrusion quality and density are defined. This process, proven in the thoria system, may make improvement and greater economy possible in the fabrication technology for ceramic shapes of zirconia, alumina, and other ceramics amenable to the sol-gel process. (auth)

1023 PRODUCTION AND PROPERTIES OF MOLTEN UO_2. Loeffler, L.; Schurig, Ch. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 11: 220-2(Aug. 1968). (In German).

Equipment and procedures for producing dense compacts of UO_2 by melting UO_2 with an atomic arc to eliminate voids, pulverizing the melt, and compacting in stainless steel capsules are described. Density attained is 95% of theoretical as compared with 92% for conventionally sintered material. (P.G.C.)

1024 METHOD FOR PRODUCING SINTERED NUCLEAR FUEL. Makino, Soji (to Hitachi Ltd.). Japanese Patent 1967-24629. Nov. 27, 1967. Filed Apr. 3, 1964.

A method is proposed for depositing adhering fissile material in the outer layer of a sintered ceramic fuel, with resulting increased density. The method leads to increased burn-up, increased heat conductivity, and improved fission-gas containment. A solution or slurry of a fissile material is made to soak into the pores of a sintered (or other) ceramic fuel. The solvent is then removed from the fuel leaving only the fissile material. (NSA of Japan)

1025 CONCRETE OF THE ATOM. Pontet, Georges. Sci. Avenir, No. 256, 492-7(June 1968). (In French).

The advantages of prestressed concrete over steel in a variety of construction problems in nuclear technology are reviewed. The problem was demonstrated in the construction of the EDF 2 and EDF 3 power plants, where the latter was dimensionally similar to the former but had some replacement of Mn-Mo steel by concrete; welding of steel plates presented difficulties which were avoided. The behavior of fissures in steel is also avoided. There is also the protection from radiation emanating from the core when concrete is used. The Saint Laurent units were so large (19 m dia, 50 m height) that they could not be made from steel, and concrete supplied the answer. It will be used with all graphite/gas plants and has been used in Britain for Oldbury and Wylfa plants with such good results that AGR reactors will in general be made from concrete. New French units will be larger; with new locations for fuel elements, control bars, and CO_2 lines; also, leak detectors can be introduced and new cooling systems can be used. Test plants on a smaller scale have been submitted to pressure tests. (BBB)

1026 INVESTIGATIONS ON THE PREPARATION OF LOWER OXIDES OF Nd, Sm, AND Yb. Brauer, G.; Baernighausen, H.; Schultz, N. (Univ., Freiburg i. B.). Z. Anorg. Allg. Chem., 356: 46-55(1967). (In German).

Reduction of the oxide halides of Nd, Sm, and Yb with LiH at temperatures between 500 and 800°C gave neither the rare earth monoxides reported in the literature, nor intermediate oxides with the metallic element in mixed valency states. Depending on the experimental conditions, the reduction process yielded either a mixture of rare earth metal and sesquioxide or the rare earth hydride and sesquioxide. Furthermore, SmO and YbO could not be obtained by careful oxidation of the respective metals; efforts to stabilize these monoxides in a matrix of SrO and CaO were also unsuccessful. (auth)

1027 PREPARATION OF A FILTERABLE CO-PRECIPITATE OF PLUTONIUM AND URANIUM. (to United States Atomic Energy Commission). British Patent 1,128,838. Oct. 2, 1968. Priority date Aug. 11, 1965, United States.

A homogeneous mixture of Pu oxide-U oxide suitable for use as fuel composition is prepared by adding NH_4OH to an acidic feed solution containing Pu nitrate and U nitrate in a mole concentration ratio of between 0.82 to 1.22 to coprecipitate the hydroxides of Pu and U, and then filtering, washing, and drying the precipitate. The precipitate is then heated in a H_2 atmosphere to a temperature of between 600 and 900°C until the U-Pu hydroxide mixture is reduced to the oxide. (B.L.M.)

1028 MIXED CRYSTAL FORMATION OF UN WITH NITRIDES OF THE RARE EARTHS CeN AND NdN. Holleck, H.; Smailos, E.; Thuemmler, F. (Kernforschungszentrum, Karlsruhe, Ger.). J. Nucl. Mater., 28: 105-9(Oct. 1968). (In German).

(U,Ce)N and (U,Nd)N solid solutions were prepared by annealing pellets of the constituent nitrides between 1800 and 1900°C for a long time. From x-ray investigations it is concluded that the system UN-CeN and UN-NdN are completely miscible. The difficulties in attaining equilibrium with these nitride systems are described. (auth)

1029 FORMATION OF U_2C_3. Nickel, H.; Saeger, H. (Kernforschungsanlage, Juelich, Ger.). J. Nucl. Mater., 28: 93-104 (Oct. 1968). (In German).

It is concluded that by heating melted alloys of UC-UC_2 at a temperature of 1350°C, the sesquicarbide may be formed either by the synthetic reaction (a) $UC + UC_2 \rightleftharpoons U_2C_3$ or by the decomposition reaction (b) $2\,UC_2 \rightleftharpoons U_2C_3 + C$. However the two reactions occur at different speeds. While at a temperature of 1350°C the reaction (a) proceeds in a few hours (<3hr), the uranium dicarbide

decomposes more slowly. The UC only reacted with the UC_2-matrix after U_2C_3 nuclei had formed at cracks. Therefore the heating of pure UC_2 alloys does not lead directly to sesquicarbide but on the contrary takes place following this reaction (c) $UC_2 \rightleftharpoons UC + C$. It is concluded that for reaction (a), there must be tensions between the UC and UC_2 phases. These tensions lie in the micro-range and are the result of variable mutual orientations of grains of the two phases. A change in orientation may be produced by a blow or deformation of the crystal. Researches to observe directly the formation of U_2C_3 have shown that the layer of oxide (≈5 μm) which is formed at the surface of the sample during heating, always prevents the reaction forming sesquicarbide. (auth)

1030 INTERDEPENDENCE OF THE DENSITY AND GRAIN GROWTH OF SINTERED STOICHIOMETRIC UO_2. Ristic, M. M.; Sigulinsky, F. pp 975-9 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

Powder compacts of nuclear grade UO_2 were sintered at 1550°C for 4 hr in H_2 to a density 94.8% of theoretical. The compacts were annealed in He at 1500 to 1700°C and measured for density and grain size. Two stages of grain growth were indicated. In the first stage grain size and density increased simultaneously to a density of about 96%. In the second stage only grain size increased, presumably by coalescence of pores. (P.G.C.)

1031 DEVELOPMENT OF MICROSTRUCTURE IN CERAMIC SYSTEMS. Coble, R. L. pp 658-80 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The factors involved in the development of microstructures in ceramics are reviewed and discussed. Topics include kinetics of sintering single-phase bodies, liquid-phase sintering, hot pressing, grain growth, densification, lattice and grain boundary diffusion, pore growth, plastic deformation, and the influence of surface energy. Fifty-nine references. (P.G.C.)

1032 DENSIFICATION OF SINGLE-PHASE SYSTEMS UNDER PRESSURE. Spriggs, Richard M.; Atteraas, Lyder. pp 701-27 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The densification of single-phase systems under pressure by hot-pressing or pressure sintering is reviewed. The number of applications of this technique, where controlled microstructures and improved properties are objectives, is large. A brief evaluation is presented on the state of the art of pressure-sintering process mechanisms such as phenomenological plastic flow, particle rearrangement by fragmentation and grain boundary sliding, and enhanced diffusion under stress. Several recent thermochemical and thermomechanical adaptations of uniaxial pressure sintering are described. Cited as examples are decomposition pressure sintering of oxides, reaction hot-pressing of clays and oxides, phase inversion hot-pressing, liquid-phase extrusion forming, thermomechanical working, and single-crystal growth by strain annealing. (auth)

1033 METHOD OF AND APPARATUS FOR MELTING URANIUM DIOXIDE OR PLUTONIUM DIOXIDE. Schikarski, Lothar; Teiwes, Hans-Jurgen (to EURATOM). British Patent 1,132,271. Oct. 30, 1968. Priority date Feb. 8, 1965, Germany.

A method is presented of melting finely divided powder of plutonium dioxide, uranium dioxide, or a mixture of the dioxides. A charge of the dioxide powder in a crucible is provided with a current path through the charge of material of greater conductivity than the finely powdered charge. The melting of the charge is in a hydrogen atmosphere to give a stoichiometric melted product. The apparatus for the method is described. (J.C.W.)

Properties Evaluations

Refer also to abstracts 719, 1023, 1060, 2031, 2032, and 2131.

1034 (BMI-1845, Sect. A) URANIUM-PLUTONIUM NITRIDE FUELS FOR LMFBR APPLICATIONS. (Battelle Memorial Inst., Columbus, Ohio). 106p.

Synthesis, cold pressing and sintering of powders were performed in a high-purity-nitrogen atmosphere glove box train. Experiments were performed on $(U_{0.8}Pu_{0.2})N$ stoichiometric and hyperstoichiometric mechanically mixed powders, and stoichiometric and hyperstoichiometric powders prepared from arc-melted prealloyed metal. Preparation of stoichiometric uranium-plutonium monocarbonitride in a conventional arc melter at 1 atm nitrogen pressure was accomplished. At 1 atm nitrogen pressure stoichiometric monocarbide should be obtained with a melt containing 3.3 wt % carbon and a resultant absorption of 1.7 wt % nitrogen in the melt. The composition dependence on nitrogen pressure of arc-cast U-Pu monocarbonitride alloys is given. A survey to establish the experimental parameters for the preparation of U,P carbides and nitrides by the carbothermic technique included two processes for the synthesis of uranium-plutonium nitride from the oxide. The successful process involved the reaction between U,Pu oxides with carbon in flowing nitrogen. The volatilization rate for PuN was obtained by use of the electrobalance and from these data the heat of formation was calculated. Equilibrium vapor pressure determinations on $(U_{0.8}Pu_{0.2})N$ indicate that the activity of Pu is 0.2, and does not appear to be dependent upon temperature. Vaporization from a free surface of $(U_{0.8}Pu_{0.2})N$ decreases with time until steady-state is reached. Long term volatilization of PuN and $(U_{0.8}Pu_{0.2})N$ is investigated and results summarized. Improvements were made on the chemical procedures used to analyze (U,Pu)N fuels. Compatibility tests of (U,Pu)N, UN, and PuN fuels between Types 304, 316, and ORNL stainless steels, Inconel 625, Incoloy 800, U, and Nb-Zr alloy as the primary cladding for the LMFBR were performed in varying combinations. The thermal diffusivities of mixed nitrides were determined as a function of stoichiometry for the $(U_{0.8}Pu_{0.2})N$ composition and of U-P ratio. Equipment for the testing of wetting of nitride fuels and cladding materials by sodium was modified. Fuel pellets of nitride fuels for irradiation testing were prepared and loaded. After completion of thermal neutron irradiation, post-irradiation testing was begun. Fuel burnups ranged from 34,000 to 55,000 MWd/t. Specimens are being prepared for irradiation in EBR-II. (J.C.W.)

1035 (BMI-1845, Sect. C) COATED-PARTICLE FUEL MATERIALS. (Battelle Memorial Inst., Columbus, Ohio). 34p.

The pyrolytic carbon coating procedure and equipment was modified and improved and the equipment was adjusted to permit SiC deposition. Results are tabulated for PyC-coated PuO_2 materials prepared for evaluation in radiation and compatibility studies. A reliable chemical leach test can be effective in evaluating the coating of PyC-coated microspheres. Four acid solutions were tested and dissolution efficiency results given. The three effective acid solutions were then tested on three samples of uncoated PuO_2 microspheres produced by Sol-Gel, plasma torch, and mechanical shaping and sintering to evaluate the effect of microsphere fabrication on dissolution behavior. Experiments on spherical PuO_2 particles coated with a porous 35-μ inner PyC coating and a dense 87-μ outer PyC coating demonstrated the excellent thermal stability of this coated-particle system from 1500 to 2000°C. A series of determinations of the effect of heat treatment on the stoichiometry of the PuO_2 substrate was conducted. A sweep-capsule irradiation was conducted to evaluate the coating integrity of PyC-coated particles by measuring their fission-gas retention as a function of temperature and burnup. Coated UN material was prepared for evaluation in the irradiation and compatibility studies. (J.C.W.)

1036 ELONGATION TO FRACTURE OF UNBONDED CERMETS. Butcher, B. R. (United Kingdom Atomic Energy Authority, Harwell, Eng.); Cope, L. H. Int. J. Powder Met., 4: No. 4, 49-57(Oct. 1968).

Three models were examined for their suitability as a basis for calculating the extensions of unbonded cermets on the criterion of their minimum web thickness being unaltered by extension, even though the web itself changes shape. The most comprehensible simple model is used to calculate the extension to fracture, comparing both linear and parabolic stress-plastic strain relationships. The results calculated on the parabolic stress-plastic strain basis for three particular cermets agree reasonably well with those obtained experimentally. (auth)

1037 DETERMINATION OF OXYGEN DIFFUSION IN CERAMICS BY MEANS OF NUCLEAR ACTIVATION. Condit, R. H.; Holt, J. B. (Univ. of California, Livermore). Ber. Deut. Keram. Ges., 45: 465-8(Sept. 1968). (In German).

A technique was developed which makes it possible to use ^{17}O and ^{18}O as if they were radioactive tracers. This technique makes use of the nuclear activation reactions $^{17}O(dn)^{18}F$ and $^{18}O(pn)^{18}F$. The radioactive species ^{18}F is treated by conventional autoradiographic procedures which permits the O_2 tracer to be precisely located and its concentration measured. The use of this technique in making O_2 self-diffusion measurements and as a marker in sintering, creep, chemical reactions, and metal oxidation studies is described. (auth)

1038 YIELD AND FLOW OF SINGLE CRYSTALS OF URANIUM DIOXIDE. Byron, J. F. (Liverpool Univ.). J. Nucl. Mater., 28: 110-14(Oct. 1968).

The deformation behavior of single crystals of uranium dioxide, tested in compression at temperatures between 600 and 1800°C is reported. The temperature-dependence of the proportional limit was found to be dependent on the operating slip plane. The slip plane did not vary with temperature and was either {100} or {110} depending on orientation. (auth)

1039 MECHANICAL BEHAVIOR OF POLYCRYSTALLINE CERAMICS. Stokes, R. J. pp 379-405 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

A review is presented in which the materials are divided into three categories such as completely brittle, semi-brittle, and ductile. Variations in properties at high and low temperatures are discussed and include factors such as dislocations, migration of vacancies, creep, slip systems, plasticity, grain size, grain boundaries, symmetry, anisotropy, deformation, and mechanical properties. Forty-eight references. (P.G.C.)

1040 EFFECT OF MICROSTRUCTURE ON DEFORMATION OF CERAMICS. Vasilos, T.; Passmore, E. M. pp 406-30 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

Structural and compositional variables, which affect creep in ceramic materials are reviewed from the standpoint of crystallography, grain size, porosity, substructure, segregation of impurities, deviations from stoichiometry, effects of additives, and solid solution alloying. Equations are developed to explain relationships between test variables and specific combinations of materials. Analyses are presented of experimental results of creep tests on MgO, Al_2O_3, and BeO. Forty-one references. (P.G.C.)

1041 SUPERCONDUCTIVITY OF CERAMIC COMPOUNDS. Ralls, Kenneth M.; Parker, Earl R.; Zackay, Victor F. pp 489-508 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The effects of microstructure on the superconductivity of various carbides and nitrides having a NaCl (B1) structure are reviewed as are the properties of complex carbides and nitrides of βMn (A13) structure. The effects of structural variables on the three main superconductive properties of ceramics, lack of electric resistivity below the critical temperature, diamagnetism at low magnetic fields, and critical current density are discussed. Forty-seven references. (P.G.C.)

1042 IMPORTANCE OF MICROSTRUCTURAL CONSIDERATIONS IN THE PERFORMANCE OF STEEL PLANT REFRACTORIES. Kappmeyer, K. K. pp 522-58 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The application of microscope techniques in evaluating the effects of microstructure on the properties of steel plant refractories is discussed, particularly in relation to the development of high-alumina and SiC bricks. Properties and performance of conventional refractories for coke ovens, blast furnaces, and open hearths are reviewed as are results of experiments with BN, B_4C, AlN, ZrB_2, and zirconia refractories. (P.G.C.)

1043 STRUCTURE-SENSITIVE PROPERTIES OF ARC-MELTED CARBIDES. Rossi, R. C.; Carnahan, R. D. pp 620-35 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The relations between microstructure and properties of composites of the group IV carbides and graphite are presented and shown to be strongly dependent on total C content. Of particular importance is the enhanced resistance of hypereutectic carbide-graphite alloys to thermal stress environments. Although this composition range is mechanically weaker than hypoeutectic alloys the thermal shock resistance is attributable to their inherent capacity for absorption of elastic energy released by a propagating crack and the ability of graphite flakes to blunt a crack tip. (auth)

1044 SOME EFFECTS OF POWDER CHARACTERISTICS ON DENSIFICATION AND MICROSTRUCTURE. Livey, D. T.; O'Neill, J. S.; Hey, A. W. pp 800-27 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

Effects of ceramic powder characteristics, particle size and shape, crystallite size and aggregations of crystallites, and impurities, on densification and microstructure of ceramic bodies are discussed particularly as they affect the sinterability of beryllia, thoria, and urania. (P.G.C.)

1045 CHANGE IN THE PROPERTIES OF ZIRCONIUM–YTTRIUM SOLID SOLUTIONS DURING EXTENDED EFFECT OF HIGH TEMPERATURE. Kuznetsov, A. K.; Zimina, L. A.; Keler, E. K. (Inst. of Silicate Chemistry, Moscow). Izv. Akad. Nauk SSSR, Neorg. Mater., 4: 1112-17(July 1968). (In Russian).

Solid solutions of zirconium oxide with 7, 10, and 15 mole % Y_2O_3 can be successfully used as material for the preparation of high-refractory objects. The synthesis of cubic zirconium–yttrium solid solutions with 7 mole % Y_2O_3 from mixtures of the original oxides occurred at 1700 to 1750°C. The exposure was 2 to 3 hrs. The sintering of the zirconium–yttrium solid solutions proceeded rapidly in the temperature range of 1800 to 1900°C. Complete sintering (zero porosity) did not occur even at 2000°C. In contrast to the zirconium–calcium solid solutions, the cubic solid solutions in the Y_2O_3–ZrO_2 system did not decompose under extended exposure to temperatures of 800 to 1600°C. Under extended exposure to 2000°C in vacuum the zirconium–yttrium solid solutions as well as the zirconium–calcium solid solutions became impoverished in stabilizing additions because of their evaporation. As a result a monoclinic phase appeared. Yttrium oxide evaporated slower from the solid solution than calcium oxide. (tr-auth)

1046 λ-TYPE THERMAL ANOMALY IN TRIURANIUM OCTAOXIDE AT 482.7°K. Girdhar, H. L.; Westrum, Edgar F., Jr. (Univ. of Michigan, Ann Arbor). J. Chem. Eng. Data, 13: 531-3(Oct. 1968).

Heat capacities of U_3O_8 were measured by adiabatic calorimetry from 300 to 555°K. A reversible λ-type thermal anomaly of uncertain origin, and with an enthalpy of transition of only 41 cal./(mole °K), was observed at 482.7°K. (auth)

1047 ENTHALPY OF FORMATION OF NEPTUNIUM DIOXIDE. Huber, Elmer J. Jr.; Holley, Charles E. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Eng. Data, 13: 545-6(Oct. 1968).

The enthalpy of formation of neptunium dioxide was determined by means of an oxygen bomb calorimeter and found to be $\Delta H^0_{f298.15°K}$ $(NpO_2) = -256.7 \pm 0.6$ kcal. per mole. (auth)

Structure and Phase Studies

Refer also to abstract 1043.

1048 (KFK-737) PHASE EQUILIBRIUM IN THE SYSTEMS UO_{2+x}–$LuO_{1.5}(ErO_{1.5})$ AND $LuO_{1.5}$–$UO_2(NpO_2, NpO_{2+x}, PuO_2, PuO_{2+x})$. Sriyotha, Udom (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Apr. 1968. 61p. (In German). Dep.

The systems $LuO_{1.5}$–$UO_2(UO_{2+x}, NpO_2, NpO_{2+x}, PuO_2 \cdot PuO_{2+x})$ and $ErO_{1.5}$–UO_{2+x} were investigated in the temperature range from 1270 to 1700°C and under 1 atm O_2 or under no oxygen. The width of the oxide phases formed in the individual systems was determined as a function of the individual parameters. (tr-auth)

1049 LIQUIDUS CURVE MEASUREMENTS IN THE ZrO_2–MgO SYSTEM WITH THE SOLAR FURNACE. Noguchi, Tetsuo; Mizuno, Masao (Government Industrial Research Inst., Nagoya, Japan). Bull. Chem. Soc. Jap., 41: 1583-7(July 1968).

A liquidus curve in the system ZrO_2–MgO was investigated by the use of a heliostat type solar furnace. The cooling curves of a composition were obtained by the specular reflection method with a brightness pyrometer. Quenched specimens from the melt were examined using an x-ray technique and a petrographic microscope. Newly found anomalies on the liquidus curve were 7.5, 12.5, and 17.5 mole % MgO compositions. The composition of 12.5 mole % MgO quenched from the melt showed the new cubic-like phase of which optic angle of 2V equals to −74° and decomposed easily into monoclinic and tetragonal forms by reheating at 1300°C. (auth)

1050 MICROSTRUCTURAL CHANGES IN UN FUEL ELEMENTS UNDER THE INFLUENCE OF A TEMPERATURE GRADIENT. Kubota, Tadashi; Takahashi, Shuichiro (Mitsubishi Atomic Power Ind., Omiya, Japan). Nippon Kinzoku Gakkaishi, 32: 665-9(1968). (In Japanese).

Microstructural changes of UN fuel elements including vibratory compacts of arc-fused UN, sintered pellets containing high UO_2 impurity, and the vibratory compacts of powder prepared by crushing sintered pellets were investigated using a steep temperature gradient by center-line heating technique at high temperatures in a vacuum of 1.0×10^{-4} mmHg. In the central regions of UN fuels, where the temperature was above 1800°C, uranium metal was precipitated by the decomposition of UN. Columnar grain growth, which was usually observed in UO_2 fuel heated under a temperature gradient in vacuum, was not found to occur. There was no appreciable difference in the microstructural changes between vibratory compacts of arc-fused UN containing low UO_2 impurity and the vibratory compacts of powder prepared by crushing sintered pellets containing a high UO_2 impurity. The microstructure at the interface of UN–UO_2 contact pellets after center-line heating was investigated. (auth)

1051 NOTE ON THE OCCURRENCE OF EXAGGERATED GRAIN GROWTH IN SINTERED BODIES. Amato, I. (FIAT, Turin); Colombo, R. L. J. Nucl. Mater., 28: 120-3(Oct. 1968).

Observations were made of exaggerated grain growth in a pellet of UO_2 sintered at 1750°C for periods from 7 to 50 hours. Theories are advanced to explain the mechanisms involved and the effect of pores upon the grain boundaries. (P.G.C.)

1052 THERMODYNAMICS OF THE DISSOLUTION OF OXYGEN AND NITROGEN IN URANIUM MONOCARBIDE. Alcock, C. B.; Javed, N. A.; Steele, B. C. H. (Imperial Coll. of Science and Tech., London). Bull. Soc. Fr. Ceram., No. 77, 99-108 (Oct.-Dec. 1967). (In French).

Partially oxygenated samples of UC were analyzed by chemical methods and by crystallographic techniques. The lattice parameter is shown to vary linearly with (O/O + C) from 4.961 Å at 0.07 to 4.9515 Å at 0.33. The activity coefficient at 1300°C for UC is given as follows as a function of (X_{UC}): 0.99 (0.9), 0.93 (0.85), 0.78 (0.8), 0.60 (0.75), 0.49 (0.7). Lattice parameters for the composition range of UOC are plotted as a function of the partial pressure of O_2 and as a function of the time allowed for approach to equilibrium. Free energies of formation are plotted as a function of temperature for a number of metal-oxide systems, and the formation of oxycarbides from other carbides is discussed in terms of the activities of C and O in the compound. Monoxides which like UO are unstable except in an oxycarbide phase include those of Ta, Mo, and W. Thermodynamic properties of U carbides are discussed, and the details of N and O solution in UC, of the method of equilibrium studies, and of electrochemical studies in molten salts are reviewed. (BBB)

1053 POWDER-DIAGRAM AND SPECTROSCOPIC STUDIES OF MIXED OXIDES OF LANTHANIDES AND QUADRIVALENT METALS. Joergensen, Chr. Klixbuell; Rittershaus, Elfriede. Kgl. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 15, 37p (1967).

Praseodymium and Tb occur predominantly as Pr(III) and Tb(III) in ZrO_2 whereas the strongly colored Pr(IV) and Tb(IV) are formed in ThO_2. The uncorrected optical electronegativities of these central atoms are 2.6 and 2.55 in agreement with the general theory for 4f . The disordered fluorites $M_{0.2}Zr_{0.8}O_{1.9}$ were studied spectroscopically. They showed a slightly weaker nephelauxetic effect than the C-$M_2O_3 \cdot LaErO_3$ and the related materials such as $La_{0.4}Er_{0.4}Zr_{0.2}O_{1.6}$ were also investigated. The new type $NdYO_3$ was found in a large variety of mixed La–Nd–Sm–Ti–Zr oxides prepared by ignition of co-precipitated hydroxides at 1000°C. Bi_2O_3 containing small amounts of Nd(III) or Er(III) is a disordered fluorite; the relations to senarmontite–Sb_2O_3 and $M2Bi_{24}O_{40}$ are discussed. The absorption spectrum of Ce(IV) acetylacetonate was measured. Comparisons were made with the unusual octahedral 4f group and 5f group hexahalide complexes. The variable polarizability and optical electronegativity of oxide are discussed. (BBB)

1054 DIFFUSION OF OXYGEN IN GROWING ZIRCONIA FILMS. Cox, B. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Pemsler, J. P. J. Nucl. Mater., 28: 73-8(Oct. 1968).

Specimens of oxidized zirconium into which $^{17}O_2$ had been diffused during oxidation, were remeasured with an ion microprobe mass spectrometer. The presence of a thin diffusion zone near the surface in addition to the deeper diffusion profile identified by the previous technique [using the $^{17}O(^3He,\alpha)^{16}O$ reaction] was demonstrated. The two methods gave good agreement for the deep penetration, which is ascribed to a line or surface diffusion process via dislocations or crystallite boundaries in the oxide. The thin diffusion zone near the oxide/gas interface is ascribed to the lattice diffusion of oxygen in zirconia. Separation of the two profiles permits the lattice and line (or surface) diffusion coefficients to be calculated. The latter is larger than the former by a factor of about 10^4 at the temperatures used (400 to 500°C). (auth)

1055 TRANSMISSION ELECTRON MICROSCOPY OF THIN (<2000 Å) THERMALLY FORMED ZrO_2 FILMS. Ploc, R. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 28: 48-60(Oct. 1968).

The mode of ZrO_2 formation on bulk zirconium at 300°C in 760 Torr of dry oxygen was investigated. Zirconia films less than 2000 Å in thickness were chemically removed from their substrates and studied in transmission in an electron microscope. An interpretation of the Zr/ZrO_2 epitaxy on a zirconium (0001) plane is given. All films contained oxide crystallites which ranged in size from the detection limit of the imaging technique (≈30 Å) to 250 Å. In some instances, up to 30 or 40% of the projected film area lacked long range crystal order (i.e., more than a few atom spacings). (auth)

1056 KNOWLEDGE OF THE SYSTEM URANIUM–ZIRCONIUM–CARBON. Nickel, H.; Inanc, Oe.; Luecke, K. (Kernforschungsanlage, Juelich. Technische Hochschule, Aachen). J. Nucl. Mater., 28: 79-92(Oct. 1968). (In German).

The lattice parameters of pure solid solutions of (U, Zr)C in melted and annealed alloys were determined. The change of the lattice parameters as a function of the composition revealed a small deviation from Vegard's law. To establish the phase diagrams, melted and homogeneous samples were quenched from different temperatures, and subsequently examined by x-ray diffraction. The composition of the solid solution (U, Zr)C in equilibrium with UC_2 and C was found to be 39 ± 3 mol % UC at 1700°C, 32 ± 2 mol % UC at 1900°C and 23 ± 2 mol % UC at 2000°C. The constituents UC and ZrC and the solid solution (U, Zr)C have a homogeneity range. The phase-boundary between the solid solution (U, Zr)C and the two-phase field [(U, Zr)C + (U, Zr)] at 1700°C was determined with a microprobe-analyzer. The same method was used for analyzing the (U, Zr)C phase in equilibrium with (U, Zr). For pure zirconium carbide, the phase-boundary is situated at 38.4 at.% C ($ZrC_{0.62}$). With increasing uranium content the homogeneity range decreases rapidly to about 47 at.% C [(U, Zr)$C_{0.88}$] and remains constant up to pure uranium carbide ($UC_{0.88}$). (auth)

1057 EFFECT OF ZIRCONIUM ALLOYING ON HIGH TEMPERATURE OXIDATION OF NIOBIUM. Yamawaki, Michio; Mukaibo, Takashi (Tokyo Univ.). Denki Kagaku, 36: 671-5 (Sept. 1968). (In Japanese).

The thermal oxidation of Nb and Nb–Zr alloys containing from 2 to 7 at. % Zr was investigated by thermogravimetric measurement, x-ray diffraction, metallographical methods, and microhardness measurement. The tests were conducted at 485 to 935°C in dry air. Five modifications of the dominant product Nb_2O_5 i.e., δ, $\delta \cdot \gamma$, γ, α' and α were identified and the transition temperature of each modification was observed to be raised with increasing Zr content in the substrate. It was confirmed that there is an intimate relationship between the thermal transitions of Nb_2O_5 and the change of scale morphology. Anomalous weight gain curves were observed in the middle temperature range, which were explained in connection with the formation of cavities which reduced the area of ion transport in the γ- or $\delta \cdot \gamma$-Nb_2O_5 scale. The $\delta \rightarrow \delta \cdot \gamma$ transition of Nb_2O_5 was closely related with the remarkable change in the reaction mechanism. (NSA of Japan)

1058 STRUCTURAL REFINEMENT OF $U_{20}C_3Si_{16}$. Silvestre, G.; Blum, P.-L. (Centre d'Etudes Nucleaires, Grenoble, France). Bull. Soc. Fr. Miner. Crist., 91: 233-6(May-June 1968). (In French).

The crystal structure refinement of the compound $U_{20}C_3Si_{16}$ is discussed. Special emphasis is given to the choice of experimental procedure for overcoming difficulties arising from the strong absorption by the crystal. (auth)

1059 MICROSTRUCTURES DEVELOPED IN CERAMIC NUCLEAR FUEL. Weidenbaum, B.; Hausner, H.; Lyons, M. F. pp 947-57 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

Fuel rods of Zircaloy-2 clad UO_2 pellets were irradiated at progressively higher surface fluxes in a pressurized water loop with a coolant temperature of 275°C until increasingly larger amounts of UO_2 operated in the molten state. The location of the molten boundary zone of the fuel furnished a basis for obtaining the thermal conductivity coefficient of UO_2 between surface temperature and its melting point. Microstructures developed in

laboratory experiments were analogous with those produced in two fuel rods operated for several weeks at significantly different power levels. (P.G.C.)

1060 MICROSTRUCTURES DEVELOPED FROM FUSION CASTING. Alper, Allen M. pp 763-99 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The fusion-casting process permits the development of very unusual microstructures. One interesting characteristic of this process is the dendritic crystallization of the phases. Also, the formation of euhedral and subhedral crystals often occurs in fused-cast refractories. The grain size of the phases, the distribution of phases, the composition of phases, and the phase assemblages can be modified by controlling process variables and/or composition variables. These materials are particularly good in corrosive and erosive high-temperature environments. Fused-cast refractories can be made that are resistant to corrosion by glass, even though they contain a glassy phase in amounts as high as 30% by volume. A fused-cast refractory composed of $ZrO_2-Al_2O_3-SiO_2$ is resistant to attack by molten glass although its glassy phase is molten at use temperatures. Even though the matrix melts, the grains do not become readily eroded, because they are interwoven. (auth)

1061 OPTICAL MICROSCOPY IN CERAMIC ENGINEERING. Allen, Alfred W. pp 121-59 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

The role of optical microscopy in the primary analysis of the microstructure of ceramic materials is reviewed. Included is information on the ceramic concept of microstructure, optical examination of macrostructures, relation of microstructure to process engineering, surface treatment of specimens, illumination for optical systems, determination of microhardness, phase contrast, metasomatism, anisotropy, quantitative optical microscopy, and ocular systems. Fifty-three references. (P.G.C.)

1062 TRANSMISSION ELECTRON MICROSCOPY OF CERAMICS. Doherty, P. E. pp 161-85 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

Discussions are presented concerning the application of transmission electron microscopy to studies of nucleation, grain growth, phase separation, and dislocations in glass, ceramic, and glass-ceramic materials. (P.G.C.)

1063 CERAMIC SURFACES AND RELATIONSHIP TO INTERNAL MICROSTRUCTURES. Wolkodoff, Vladimir E.; Ferreira, Laurence E.; Weaver, Robert E. pp 297-309 of Ceramic Microstructures. Their Analysis, Significance, and Production. Fulrath, Richard M. (ed.). New York, John Wiley and Sons, Inc., 1968.

From 3rd International Materials Symposium on Ceramic Microstructure, Berkeley, Calif. See CONF-660619.

A brief review of relations between internal microstructure and ceramic surfaces is presented. Definitions are given of the term microstructure, as associated with ceramic materials, and based upon composition, texture, structure, and surface characteristics. Twelve references. (P.G.C.)

Radiation Effects

1064 RADIATION EFFECTS IN SOLID SURFACES. Gilmore, G. R.; Newton, G. W. A. (Univ. of Manchester, Eng.). pp 58-99 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The effects of radiation on the surface properties of alumina were investigated. The material used for this investigation was $\gamma-Al_2O_3$ prepared by heat treatment of high-purity bayrite, and was chosen for the following reasons: the surface properties are well documented; the metastability of the high surface area was known to lead to radiation sensitivity; and targets could be obtained in a high state of purity. The surface properties, both before and after irradiation under different conditions, were characterized using a combination of nitrogen gas adsorption, solution kinetics, density measurements, and adsorption from solution. The effects of radiation were different from those obtained by heat treatment of the sample, because although the surface area decreased in both cases, the pore distribution changes were quite different. Various possible models for the radiation effects are presented. (auth)

1065 SURFACE REACTIVITY OF IRRADIATED MAGNESIUM OXIDE. EFFECTS OF DOSE ON DEFECT CONCENTRATIONS, SPECIFIC SURFACE AREAS AND CHEMISORPTION KINETICS. Nelson, R. L.; Hale, J. W.; Harmsworth, B. J.; Tench, A. J. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Faraday Soc., 64: 2521-32(Sept. 1968).

The ESR signals from F, V, and S centres were measured in MgO over the fast neutron dose range from 5×10^{16} to 10^{20} fast neutrons cm^{-2}. S centres are initially generated at a faster rate (% available sites per unit dose) than F centres but saturation concentrations of these isolated defects are similar. The specific surface areas of some MgO powders increase on neutron irradiation and this effect was ascribed to a fragmentation of aggregates at grain boundaries. The fresh surfaces thus produced can play an important role in the radioinduced reactivity of MgO towards oxygen. The height of the charge barrier produced by reaction of oxygen with F centres was inferred from the chemisorption kinetics and is shown to be inversely proportional to the F centre concentration, in agreement with theory. (auth) (UK)

Plastics and Other Materials

1066 QUALITY CONTROL OF CONCRETE BY A NEUTRON MOISTURE METER. Kaga, Hideharu; Yamamoto, Moriyuki (Taisei Construction Co., Ltd., Japan). Semento Konkurito, No. 252, 28-36(Feb. 1968). (In Japanese).

When mixing together concrete materials according to prescribed proportions in the concrete batching plant, the surface moisture on the aggregate has an important bearing on the quality control. This moisture differs from one batch to another, depending on the location of its stock-yard. However, the ordinary methods cannot sufficiently satisfy the requirements. Employing a neutron moisture meter such control was carried out with the sand, which has the largest fluctuation in surface moisture. The moisture detection probe was placed within the sand in a test bottle, to measure it in each batch, leading to the automatic control. The results of this control, performed over six months at a construction site, are described, and the principles used are discussed. (NSA of Japan)

1067 METHOD OF GRAFT POLYMERIZATION. Tsuji, Yoshio (to Sumitomo Electric Industries, Ltd.). Japanese Patent 1968-14349. June 17, 1968. Filed Aug. 21, 1964.

A method is proposed by which two different compounds can be graft-polymerized onto the respective sides of a film material. The advantages to the method are the simple process, strong attachment of the compounds, high mechanical strength, and uniform quality. Auxiliary films are attached on both sides of the film; the film and the auxiliaries adhere to each other at the edges, thereby producing bags. The compounds to be graft-polymerized onto the film are placed in the respective bag-spaces. Then, the whole is irradiated to bring about the graft-polymerizations. After completing the process, the auxiliary films are stripped off the product. (auth)

1068 THERMAL ANNEALING STUDIES OF IRRADIATION DEFECTS IN GRAPHITE AND THE SELF-DIFFUSION MECHANISM. Thrower, P. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 18: 697-715(Oct. 1968). (AERE-R-5666).

Electron microscope studies of high-temperature irradiation damage in single crystal and pyrolytic graphites revealed differences in the defect nucleation behaviour, which must be attributed to the differing crystallite perfection (Thrower 1967). A study of the formation and annealing of these defects, both vacancy and interstitial loops, confirmed the earlier suggestion of Turnbull and Stagg (1966) that self-diffusion in graphite is three-dimensional. Furthermore, there are several pointers to this diffusion occurring by an interstitial mechanism. During both nucleation and annealing there is evidence of interstitial migration perpendicular to the basal planes. Analysis of the results gives a value of 6.55 ± 0.4 eV for formation energy of an interstitial, and the implications of this value are discussed, the most important being that there must be a significant amount of bonding between the interstitial atom and the lattice. During annealing loops move parallel to the basal plane by a pipe diffusion mechanism, the activation energy for which is slightly lower in a twist boundary than in the lattice, due to the lower strains around the defect. There is also some evidence of loops that appear to be noncoplanar amalgamating, and there appears to be no satisfactory explanation for this. (auth) (UK)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstract 1700.

Stars

Refer also to abstracts 1577 and 1578.

1069 (N-68-27383) THE PRE-HAYASHI PHASE OF STELLAR EVOLUTION. Cameron, A. G. W. (National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies). [1968]. 16p. (NASA-TM-X-61135; CONF-680317-2). CFSTI.

From Conference on Low Luminosity Stars, Charlottesville, Va.

The structure and evolution of protostellar disks ("stellisks") were studied. These are flattened fragments of a collapsed interstellar cloud. Their angular momentum properties are those appropriate to uniformly rotating spheres of variable density distribution. Corresponding to each angular momentum distribution there are two separate density distributions in which there is centrifugal equilibrium in the disk. One distribution is very flat, rotates approximately uniformly, and probably deforms into a close binary pair. The other is axially condensed and is the probable precursor of single stars and planetary systems. In stellisks of the latter kind with lower densities near the rim, one of a few separate rings form near the outer edge. Since stellisks are formed as a result of a dynamical collapse process, they have an initial stage of short-lived turbulence. This transports angular momentum outwards and increases the tendency for formation of outer rings. (auth) (STAR)

1070 SUPERNOVA REMNANTS AS RADIO SOURCES. Kesteven, M. J. L. (Univ. of Sydney). Aust. J. Phys., 21: 739-54(Oct. 1968).

The results of a survey with the 1-mile Molonglo cross-type radio telescope of nonthermal galactic sources are discussed in terms of supernova remnant theories. The contour maps obtained indicate that most sources are consistent with a portion of a shell of emission. The results suggest that a remnant's spectral index is independent of its age. A supernova remnant evolutionary path is also derived and compared with the path predicted by the various theories. (auth)

1071 OPTICAL AND RADIO OBSERVATIONS OF THE FLARE STAR UV CETI IN AUSTRALASIA DURING SEPTEMBER–OCTOBER 1967. Higgins, C. S. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales); Solomon, L. H.; Bateson, F. M. Aust. J. Phys., 21: 725-34(Oct. 1968).

This paper presents the results of a joint radio–optical program of observations in Australasia on the flare star UV Ceti during an observing period in September–October 1967 organized by Commission 27 of the International Astronomical Union. Eight of the 21 optical events were recorded by more than one observatory and are regarded as certain flares. Six of the verified flares were also monitored at radio frequencies and 5 of these were accompanied by radio emission. Two bright flares were recorded within a time interval of 2 hr on October 3, 1967. On existing evidence, it is suggested that if a flare period does exist, it is probably shorter than 0.1821 day. Over the range $80 < f < 2650$ MHz, the average spectrum of radio bursts from UV Ceti decreases with increasing frequency. The exponent of an assumed power law variation is less than −1 below 240 MHz and steeper at higher frequencies. (auth)

1072 PROPAGATION OF SHOCK WAVES IN A POLYTROPE WITH A POLOIDAL MAGNETIC FIELD. Sinha, Narendra K. (Monash Univ., Clayton, Australia). Aust. J. Phys., 21: 681-93 (Oct. 1968).

The propagation of a spherically developed shock wave in a polytrope with a poloidal magnetic field has been studied using a generalization of Whitham's method. The effect of the magnetic field on the geometry of the front as well as on the effects brought about by the shock has been discussed. (auth)

1073 APPROXIMATE MODEL ATMOSPHERES OF F STARS. Kipper, T. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 303-13(1968). (In Russian).

A set of model atmospheres was computed for F stars. A $T(\tau)$ relationship was adopted which was obtained by Mihalas for Balmer-line-blanketed model atmospheres of an F2V star. The equation of hydrostatic equilibrium was solved using the iteration method. The ratio of electron and gas pressure and continuous absorption coefficients were taken from the tables of Bode. (auth)

1074 SPECTROSCOPIC STUDY OF COOL STARS IN THE NEAR INFRARED. Wyckoff, Susan. Cleveland, Case Western Reserve Univ., 1967. 113p.

Low dispersion near infrared slit spectra of a sample of M, S, and carbon stars were examined. It was found that the spectral types of 17 M-type long-period variables observed near minimum light define a period–spectrum relation which parallels, at ~3 sub-types later, the analogous relation for types at maximum light. Changes in molecular band strengths as a function of phase in the spectra of several stars reaffirm the temperature changes in M and S long-period variables. Four unidentified infrared bands first found by Keenan probably characterize the cooler S stars with high Zr/Ti abundance ratios. Infrared spectra of R Cyg indicate the four bands are quite sensitive to phase in the light cycle. A small sample of carbon stars has been classified according to criteria in the visual spectral region. Evidence is presented that the infrared bands of the red cyanogen system weaken at spectral types later than C7. In addition two infrared spectrograms of the class of stars intermediate between carbon and S exhibit cyanogen band strengths comparable to those found in the latest and presumably coolest carbon stars. (Diss. Abstr.)

1075 PHOTOMETRIC AND SPECTRAL VARIATIONS OF GIANT M STARS. Houk, Nancy Mia. Cleveland, Case Western Resere Univ., 1967. 184p.

Spectral changes with phase of 121 long-period variables of type M in Groningen-Palomar Field 2 ($l^{II} = 4°$, $b^{II} = 12°$) were studied, using objective-prism plates and the infrared region for classification. Spectral types for each star are determined at from 7 to 18 distinct epochs. Variables having photographic magnitude ranges of 2 or 3 magnitudes or more show spectral changes of several subtypes in the course of their light cycle, the earliest spectral type occurring at photometric maximum, and all the variables reaching type M6.5 or later at minimum. Periods were determined for about 60 variables, and spectral subtype was plotted against phase for 39 larger-amplitude variables. Period-spectrum relations for maximum and minimum spectral types are roughly parallel and separated by about four spectral subtypes. Magnitude variability of 700 M stars in Field 2 and 345 in VSF 193 ($l^{II} = 10°$, $b^{II} = -6°$) was investigated, completeness of discovery being carefully evaluated. In both regions approximately half the stars are variable with photographic ranges exceeding 0.4 mag. The percent variable with ranges of less than one magnitude is nearly independent of spectral subtype, unlike the case for larger-amplitude variations. In Field 2, 17%, and in VSF 193, 44%, of the stars vary with ranges greater than one magnitude. (Diss. Abstr.)

1076 V448 CYGNI AND V453 CYGNI: TWO ECLIPSING BINARIES IN THE P CYGNI REGION. Cohen, Howard Lionel. Bloomington, Ind., Indiana Univ., 1968. 247p.

Photoelectric UBV light curves of the double-line spectroscopic binaries V448 Cygni and V453 Cygni have been obtained at Lowell Observatory. The light curve of V448 Cygni is type EB, shows complete eclipses, large asymmetries and other vagaries. The color changes confirm the difference in spectra types but the components do not seem equally bright as has been previously suggested. The mass ratio is uncertain due to the anomalous radial velocity curve of the 09.5 component. If the mass ratio is correct, the light curves suggest that the less-massive Bl Ib-II companion fills its inner contact surface but its O companion does not. The type-EA light curves of V453 Cygni appear relatively free of complications. Although there are no color changes, a slight difference in surface brightness is indicated ($J_1/J_2 = 1.1$). The system appears to be composed of two detached B 0.5 IV stars with an orbital eccentricity of 0.01. Although the eclipses are complete, it is not clear which minimum is the occultation. Assuming that Min. I. = transit, $M_1 = 17\ M_\odot$, $M_2 = 13\ M_\odot$, $R_1 = 9.3\ R_\odot$, and $R_2 = 5.7\ R_\odot$. It is believed that these systems may be associated with the young galactic cluster NGC 6871, which is placed at a distance of 1.9 kpc from Hβ and UBV observations. However, the derived effective temperatures, even for V453 Cygni (28,000°K), are uncertain due to difficulties in obtaining absolute bolometric magnitudes. The O component of V448 Cygni appears to obey the mass–luminosity–radius law for detached binary systems, while the B star is overluminous for its mass. Similarly, the secondary component of V453 Cygni departs from this relation, but only if Min. I = occultation. Five spectrograms (63A/mm) of V448 Cygni, made with the 36-inch telescope of Kitt Peak National

Observatory, were measured for radial velocity on a Grant measuring engine, The observed radial velocities of the B star fit Petrie's computed radial velocity curve (after addition of a zero-point shift of +21 km/sec), but the radial velocities of the O star deviate from two-body motion. However, the measurement errors of the O star's lines are very large (±50 km/sec). It is concluded that the absolute dimensions of V448 Cygni cannot be regarded as genuine, but V453 Cygni seems capable of providing reliable data. (Diss. Abstr.)

1077 SHORT-TERM VARIATIONS IN LINE STRENGTHS OF PLANETARY NEBULAE. Evans, D. S.; Cathchpole, R. M.; Jones, D. H. P. (Royal Observatory, Cape of Good Hope, South Africa. Radcliffe Observatory, Pretoria). Nature (London), 220: 249 (Oct. 19, 1968).

The observations reported arose during a program to measure the radial velocities of southern planetaries, using a Newtonian spectrograph on the Radcliffe 74-inch telescope. It was suspected that in some planetary nebulae the line strengths varied with time, and even within the duration of the programme, the evidence in one case being sufficiently good to warrant reporting. For IC 2642 it could have been expected that the forbidden oxygen doublet at 3727 Å would have shown a photographic line strength estimate of about 50, but on three spectra there was no sign of it, and it appears that the spectrum has changed at some time during the past few years. The 3727 Å doublet is one of the most important lines both observationally and theoretically in the spectra of planetaries, and the possibility that line strengths may vary may have far reaching effects on the theory of these objects. The explanation probably lies in a variation of the exciting star. (UK)

1078 SUPERCONDUCTIVITY IN WHITE DWARFS AND PULSARS. Ginzburg, V. L.; Kirzhniz, D. A. (Lebedev Inst. of Physics, Moscow). Nature (London), 220: 148-9(Oct. 12, 1968).

It is possible, although not proved, that pulsars are magnetic white dwarf stars, and if so they are cold, and cannot be observed in the visible region. Attention is drawn to the possibility that for cold magnetic white dwarfs superconductivity of a layer of the star may be of great importance. The critical temperature for the transition to superconductivity, T_c, depends rather strongly on the chemical composition of surface regions, where the superconducting state is expected to originate. A reasonable assumption is that due to the burning-out of light elements in the course of evolution the substance in the regions in question has high Z (~10 to 20), although smaller than in the central region. For Z = 20 the maximum value of T_c is found to be ~400°K, which is reached when the density is 300 g/cm^3. Assuming the real temperature of the star to be of the order of 100°K it is found that for a white dwarf with a central density of 10^5 g/cm^3 a shell having a thickness of ~0.25 of the radius (3×10^9 cm) may be superconductive. For white dwarfs having a greater density the thickness of the superconductive layer decreases. The critical field, H_c, is estimated as ~10^4 to 10^5 oersted for T_c ~400°K and p ~300. It can be shown that the compressibility of matter in a white dwarf increases during transition to superconductivity, and in a strong gravitational field this could be important for thermodynamic calculations concerned with the superconductive transition. For most white dwarfs, with $p \gg 10^3$, superconductivity occurs only at extremely low temperatures. The possibility that superconductivity may have considerable effects on the magnetic field in the atmosphere of magnetic white dwarfs is discussed. In the presence of pulsations the kinetics of the superconductive transition become very complicated, and it may be expected that superconductivity will have a strong influence on the factors which determine the specific character of magnetic models of pulsars. (UK)

1079 AGE AND INITIAL HELIUM ABUNDANCE OF STARS IN THE GLOBULAR CLUSTER M15. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 220: 143-6(Oct. 12, 1968).

Estimates are made of the ages and initial helium abundances of stars in M15, which are among the oldest objects in the galaxy as well as representing the galaxy's most abundant stellar component. (auth) (UK)

1080 REMARKS ON THE OSCILLATIONS OF CYLINDERS AND RINGS. Perdang, J. (Liege Univ.). Astrophys. Space Sci., 2: 236-53(Oct. 1968).

The classification and the splitting of the oscillations of cylindrical and ring-shaped cosmical masses are discussed from the standpoint of group theory, for purely self-gravitating configurations, in the presence of rotation, magnetic fields, and tidal forces. A comparison is made with the corresponding results in oscillating stars. (auth)

1081 ASYMMETRY OF THE VELOCITY DISTRIBUTION IN THE ROTATING RING IN U Gem STARS. Paczynski, B.; Piotrowski, S. L.; Turski, W. Astrophys. Space Sci., 2: 254-7(Oct. 1968).

It is shown that the non-Keplerian character of the rotation of the ring of gas particles in a close binary system gives too large an amplitude of the radial velocity curve if this amplitude is determined from the positions of the emission lines of the ring. (auth)

1082 STRUCTURE OF A SHOCK FRONT IN ATOMIC HYDROGEN. III. THE RADIATIVE RELAXATION REGION. Skalafuris, Angelo J. (Smithsonian Astrophysical Observatory, Cambridge, Mass. City Coll. of New York). Astrophys. Space Sci., 2: 258-78(Oct. 1968).

A shock wave passing through a stellar atmosphere disturbs the gas, and the consequent adjustment of the fluid is a redistribution of the shock's kinetic energy among the various degrees of freedom. This paper deals with the effects of the Lyman continuum on the shock front. The shock heated gas is cooled principally by ionizing collisions of ground state atoms. This process is followed by a large quasi-isothermal region in which radiative recombinations occur. A final cycle of processes consisting of ionization, photo-recombinations to upper-level and collisional de-excitation, gives way to a sequence of statistical balances as each degree of freedom in the fluid attains equilibrium. Calculations show that to a great extent, the shock structure is separated into successive regions of internal and radiative relaxation by an intermediate layer of ionized gas appearing at high shock speeds. Numerical results are presented for a range of shock speeds typifying a cepheid atmosphere. Radiation field and gas motions in shock waves are coupled, but the gas reacts little to the radiation it produces. Only the Lyman continuum has an appreciable effect on the shock structure. The principal escape of energy from the shock wave is through continuum radiation produced in recombinations to upper levels; thus the continuum emission in the red is stronger than an equivalent blackbody. Lyman photons are trapped in the shock while 20 to 30% of the shock's kinetic energy escapes to the Balmer and Paschen continua after the Lyman continuum is in equilibrium. The post- and pre-shock lines, as well as the post-shock continuum above the Lyman constitute the only observable spectra which emanate from the shock wave. The shock structure is perturbed only by the radiation which is not observed, and its absence tends to distort the emission profile from a Planck distribution. (auth)

1083 CHANGES IN THE NEAR-INFRARED SPECTRA OF FIFTY-ONE RED VARIABLE STARS. Terrill, Chris L. Cleveland, Case Western Reserve Univ., 1967). 81p.

Objective prism spectra in the near infrared (6800 to 8800 Å) were used to follow the spectral variations of fifty-one Mira, semi-regular, and irregular variable stars with their changes in brightness. Thirty-one of the variables are of spectral type M, nineteen of spectral type S, and one, R CMi, is a weak carbon star. Diagrams are presented showing the M-type spectral variations with phase for twenty-three Mira or SRa type variables. The variations in M spectral type are found to correlate well with changes in brightness of the variables with phase. The range of spectral variation is greater for variables of greater light amplitude. Comparing one light cycle to another, a tendency is noted for variables to be somewhat later in spectral type at the same phase if they are fainter at that phase. A composite magnitude versus spectral type diagram indicates that the M spectral type changed more rapidly with magnitude for spectral types of M6 and earlier, compared to those later than M6. This is attributed to the change in the classification criteria between M6 and M7. Diagrams are given showing the variations of LaO at λ7909 and ZrO at λ6474 with phase for the Mira variables of spectral type S. One S star, S Lyr, shows bands of CN near maximum. An emission feature seen near λ8400 in the spectra of S stars near minimum is tentatively identified. (Diss. Abstr.)

1084 GRAVITY-DARKENING IN ECLIPSING BINARIES. II. EARLY MAIN-SEQUENCE SYSTEMS. Kopal, Zdenek (Univ. of Manchester, Eng.). Astrophys. Space Sci., 2: 166-70(Oct. 1968).

An analysis of the photometric ellipticity effect in close binary systems consisting of early-type main-sequence stars discloses that its excess over dynamical ellipticity is, on the whole, within limits explainable by linear laws of limb- and gravity-darkening over distorted stellar surfaces, with coefficients consistent with theoretical expectations based on the absence of convection in sub-surface layers. This contrasts with the situation encountered in an earlier investigation of W U Ma-type systems, and reveals that whereas the photometric properties of early-type main-sequence systems appear to be normal in the light of the existing theories of their light changes, it is the W U Ma-type systems which confront us with unexplained phenomena in the form of anomalously large ellipticities; but their solution is as yet nowhere near in sight. (auth)

1085 LEVEL POPULATIONS OF HYDROGEN AND HELIUM IN GASEOUS NEBULAE. Lee, Paul Dean. Urbana, Ill., Univ. of Illinois, 1968. 99p.

The strengths of the Balmer emission lines of hydrogen, the n^3D-2^3P series of helium, and the energy radiated in the free–bound continuum in the interval 10 Å beyond the respective series limits were studied for the planetary nebulae NGC 6572, 7009, 7027, 7662, IC 418, 4997, and the Orion Nebula. It is shown that if the temperatures derived from [O III] data are accepted as correct, there exists an overpopulation of the upper states of the hydrogen and helium atoms and an excess of low-energy free electrons. The excess line strengths and the low temperatures determined by others from radio recombination lines are both correlated with the widths of the spectral lines. (Diss. Abstr.)

1086 PULSATIONS OF MASSIVE STARS. Simon, Norman R. New York, Yeshiva Univ., 1968. 140p.

Models were constructed of massive stars in the core helium-burning phase of post main-sequence evolution. Tests made for stability against nuclear-energized pulsations show these models to be extremely stable as a result of the increasing central condensation which accompanies evolution away from the main sequence. Comparison of pulsation theory with observations of blue supergiants in the Magellanic Clouds yields the following consistent set: 1) a main sequence stability limit (against nuclear-energized pulsations) of ~60 $M_\odot$; 2) a zero-age chemical composition $X_e = 0.75$, $Z_e = 0.02$ to 0.03. A sharp cutoff of observed stars at ~60 $M_\odot$ indicates probably disruptive instability for main sequence stars exceeding this mass. A second group of models was built with helium-burning cores, hydrogen-poor envelopes, and a thin hydrogen shell source which may or may not be ignited. Pulsational stability tests yield the following conclusions: 1) stability is enhanced substantially by the presence of a burning shell; 2) any increase in envelope hydrogen provides a strong stabilizing influence. It is suggested that the hydrogen-poor models may represent a class of hot luminous Wolf–Rayet stars which are the products of evolution via mass loss. A first-order nonadiabatic transfer equation was derived consistent with the diffusion approximation. Such an equation should be useful in the study of variable stars. (Diss. Abstr.)

1087 MODEL OF AN EXPANDING SUPERDENSE COSMICAL OBJECT. Vartanyan, Yu. L. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 18-20 (Jan.-Mar. 1966).

Translated from Astrofizika, 2: 45-52(1966).

A model is considered of a continuously expanding cosmic object which is initially at rest. The condition of a negative mass defect, which such a model requires, leads to a limitation on the number of particles in the expanding body. (auth)

1088 INTERPRETATION OF FLARE STARS. Mirzoyan, L. V. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 60-1(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 121-4(1966).

In considering the possible formation of a hot gaseous envelope around a cool star, which necessarily requires the assumption that unknown processes occur in stars with continuous emission, the possibility of this type of explanation is examined from the point of view of observational data. For this purpose, the characteristics of the continuous emission observed during flares are determined. (W.D.M.)

1089 PHOTOELECTRIC OBSERVATIONS OF AG Dra IN 1965. Belyakina, T. S. (Crimean Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 57-9(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 115-20(1966).

Three-color photoelectric observations of AG Dra have shown that the radiation of the star remained constant on the average in the blue and yellow regions of the spectrum. Ultraviolet radiation increased considerably as compared with 1962–1963. During the period of observation there was a decrease in the intensity of uv radiation by 0.3^m, accompanied by rapid fluctuations with an amplitude of 0.1^m. It is estimated that during the period of the 1965 observations, the Balmer discontinuity decreased by 25%. The lower limit for the electron density of the gaseous component is estimated at $n_e > 3 \times 10^6$. (auth)

1090 THE VARIABLE STAR AG Dra. Boyarchuk, A. A. (Crimean Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 50-6(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 101-13(1966).

It has been found that the absorption spectrum of AG Dra corresponds to K2III. It is demonstrated that the energy distribution in the continuous spectrum can be represented as the superposition of the spectrum of an ordinary K3III star and hydrogen gas at $T_e = 17{,}000°$. It was also found that the Balmer decrement differs appreciably from the decrement computed for gaseous nebulae. The ratio of the intensities of singlet lines to triplet lines is twice as great as in the case of gaseous nebulae. On the basis of the intensities of the [O III] lines it was found that $n_e \geq 10^7$ cm^{-3}. A mass of 2×10^{-4} $M_\odot$ and a size of 2.5×10^4 $M_\odot$ were determined for the gas cloud where the emission lines are formed. Evidence is presented indicating that AG Dra and other stars of the Z And type represent double nuclei of peculiar planetary nebulae. (auth)

1091 DYNAMICS OF A COLLAPSING PROTOSTAR. Larson, Richard Bondo. Pasadena, Calif., California Inst. of Tech., 1968. 267p.

Thesis.

Numerical calculations of the dynamics of a spherically symmetric collapsing protostar have been made for various assumed initial conditions. In all cases the collapse is found to be extremely nonhomologous, the density distribution becoming more and more sharply peaked at the center as the collapse proceeds. As a result, a very small part of the cloud's mass at the center reaches stellar densities and temperatures and stops collapsing before most of the cloud has had time to collapse very far. The central stellar core thus formed subsequently grows in mass as the surrounding material falls into it, finally becoming an ordinary star when all of the original protostellar material has been accreted. During most of this time the forming star is completely obscured by the dust in the infalling cloud, the absorbed radiation reappearing in the infrared as thermal emission from the dust grains. For $M = M_\odot$ the resulting star is almost a conventional Hayashi pre-main-sequence model, but it appears quite low on the Hayashi track, at about $R \sim 2R$ For masses greater than about 2 or $3M_\odot$ the convective Hayashi phase does not exist at all. The emitted spectrum of a protostar has been calculated from a simple approximation for the radiative transfer problem in the infalling cloud, and the results have been compared with some observations which may be relevant. It appears that some observations of infrared objects and some properties of T Tauri stars may be explainable from the results. (Disser. Abstr.)

1092 THE DOPPLER EFFECT AND THE LAST RESOLVABLE LINE OF THE BALMER SERIES. Kurochka, L. N. (Kiev Univ.). Astrophysics (Engl. Transl.), 2: 67(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 131-3(1966).

A relation between the last resolvable line and the half-width of the line is given. From an investigation of O stars the Doppler half-width of the Hα line was found to be 2.5 Å and the last resolvable line to be 22. (W.D.M.)

Quasi-Stellar, Radio, and X-Ray Sources

1093 (AD-671151) ONE-DIMENSIONAL POLARIZATION DISTRIBUTIONS OVER FOUR SUPERNOVA REMNANTS AT 1418 MHz. Report No. 1968-3. Seielstad, G. A.; Weiler, K. W. (Owens Valley Radio Observatory, Pasadena, Calif.). 1968. 28p. CFSTI.

Distributions of the linearly polarized radiation at a frequency of 1418 MHz from the four supernova remnants 3C 10 (Tycho's supernova), Taurus A (Crab Nebula), 3C358 (Kepler's supernova), and Cassiopeia A were determined by synthesizing a fan beam whose small dimension is along a circle of constant declination. In addition, extremely low upper limits have been placed on the net degree of circular polarization in the integrated radiation from Tau A, 3C358, and Cas A. For the latter two sources, no smaller circularly polarized regions were found within the source dimensions using a resolution of better than 1′. Upper limits to the magnetic field strengths, modified by geometrical factors were also calculated. (auth) (USGRDR)

1094 (N-68-29434) SEARCH FOR CELESTIAL SOURCES OF GAMMA RAYS OF ENERGY GREATER THAN 100 MeV. Hearn, David R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). May 17, 1968. Contract NSR-09-015-022). 77p. (NASA-CR-95736; SAO-277). CFSTI.

A gamma-ray detector consisting of scintillation counters and a spark chamber to convert gamma rays to electron–positron pairs was flown with a balloon to an altitude of 125,000 feet for 7 hours. The image of the resulting charged-particle tracks in the spark chamber was transmitted from a vidicon television camera in the balloon gondola to a ground receiving station, where it was recorded on video tape and movie film in real time. The direction of each gamma ray recorded was reconstructed in celestial coordinates. No definite celestial sources of gamma rays were found. Using the integrated-likelihood method 95% confidence flux upper limits were found of 8.7×10^{-5} (cm^2 sec)$^{-1}$ from the Crab Nebula, 9.4×10^{-5} (cm^2 sec)$^{-1}$ from the Sun, and 2.7×10^{-4} (cm^2 sec sr)$^{-1}$ from the anticenter of the Galaxy, for photon energies above 100 MeV. Some possible evidence for gamma rays emitted during solar flares is given. The photon spectrum at 4 g cm^{-2} atmospheric depth is reported. The angular resolution of the detector and method of determining statistical upper limits of fluxes are thoroughly discussed. (auth) (STAR)

1095 OBSERVATIONS OF CEN XR-2, SCO XR-1, AND TERRESTRIAL X-RAYS. Harries, J. R. (Univ. of Adelaide); Francey, R. J. Aust. J. Phys., 21: 715-23(Oct. 1968).

Two identical x-ray experiments were flown on Skylark rockets from Woomera, Australia, during April 1967. Sco XR-1 and Cen XR-2 were observed on both flights. The Cen XR-2 flux was $(1.5 \pm 0.1) \times 10^{-7}$ erg $cm^{-2}sec^{-1}$ (2 to 8 keV) when first observed but had decreased to $(1.0 \pm 0.1) \times 10^{-7}$ erg cm^{-2} sec^{-1} and had become softer by the second flight. An x-ray flux from the Earth was observed and found to be due to solar x rays reflected in the atmosphere. (auth)

1096 X-RAYS AND GAMMA-RAYS OF EXTRA-TERRESTRIAL ORIGIN. Warmoltz, N. Medicamundi, 12: 103-18(1968).

The development of rockets and satellites during the past two decades has given astronomers the opportunity to observe the heavens undisturbed by the influence of the Earth's atmosphere. Geiger–Mueller and proportional-counters, brought by rockets to altitudes of about 250 km, have indicated the existence of x rays and gamma rays of solar and of galactic origin. Ingeniously constructed collimators and grazing-incidence x-ray telescopes are giving a gradually increasing accuracy of determination of the positions and the dimensions of the sources. The telescope is especially promising in this respect. Even pinhole-camera photographs have been made of the Sun. The mechanism of the emissions from the Sun is only known as far as it concerns the corona. For galactic radiation it is not known at all, although many processes are considered to be possible and some even very likely. Only two of the fifteen galactic sources that were discovered could be identified with known celestial objects. One coincides with the Crab Nebula, the other with a faint blue star which emits 1000 times more energy in the x-ray region than in the visible and whose x-ray emission is about equal to the total energy output of the Sun. Probably extra-galactic sources of x and gamma rays exist as well, although identification is not yet completely certain. The existence of an isotropic extra-galactic background is, however, firmly established. It is to be expected that with increasing sensitivity of measuring equipment many more sources will be discovered. In the first place more accurate measurements of the positions and the dimensions of the sources are needed as well as measurements of their spectra and the polarization of their radiation. The results will probably elucidate our ideas about the emission mechanisms and thereby give us valuable information about fundamental astrophysical processes, such as the formation of stars and the birth and the development of the Universe. (auth)

1097 PULSARS. Sci. Amer., 219: No. 4, 25-35(Oct. 1968).

The discovery of pulsars is reviewed and some of their characteristics are discussed. Possible models for the pulse mechanism are considered. (W.D.M.)

1098 MEASUREMENT OF THE DISTANCE OF PULSAR CP 0328. De Jager, G.; Lyne, A. G.; Pointon, L.; Ponsonby, J. E. B. (Univ. of Manchester, Jodrell Bank, Eng.). Nature (London), 220: 128-9(Oct. 12, 1968).

A measurement of the absorption in the radio signals from CP 0328 due to natural hydrogen has made possible an estimate of distance. The object seems to be unexpectedly far away. (auth) (UK)

1099 PULSED RADIO SOURCES. Hewish, A. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Phys. Bull. (London), 19: 352-4(Oct. 1968).

The characteristics and physical nature of pulsed radio sources are discussed, and ideas put forward to explain their existence are reviewed. (UK)

1100 NATURE OF PULSARS. Layzer, David (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London), 220: 247-8(Oct. 19, 1968).

A theory of stellar evolution taking into account magnetoturbulence, which might explain the observed properties of pulsars, is discussed. (auth) (UK)

1101 PULSAR SUPERNOVA ASSOCIATION. Large, M. I.; Vaughan, A. E.; Mills, B. Y. (Univ. of Sydney). Nature (London), 220: 340-1(Oct. 26, 1968).

A pulsar with a very short period (0.089 s) has been discovered at the position of a suspected supernova remnant, raising several interesting consequences. (auth) (UK)

1102 SPECTRA FINE STRUCTURE IN PULSAR RADIATION. Komesaroff, M. M. (CSIRO Radiophysics Lab., Epping, New South Wales); McCulloch, P. M.; Hamilton, P. A.; Cooke, D. J. Nature (London), 220: 358-60(Oct. 26, 1968).

Observations with the Parkes 210-ft radiotelescope during May and June 1968 showed spectral features in the 150-MHz emission from pulsars with bandwidths as narrow as 0.5 MHz. The sources observed were CP 1919, CP 0950, and CP 1133. A section of the U/V record for CP 0950 is shown; marked changes in the amplitudes of individual pulses are seen within frequency ranges of a few hundred kHz. A chart record is also shown for CP 1919; "bursts" of pulses, each lasting about 1 min, recur at intervals of 2 or 3 min, and it is seen that at any time the pulse amplitude may vary markedly within a narrow frequency range. A significant feature is that whereas the pulse to pulse correlation between adjacent channels of the recorder remains high during any one burst, the ratio of the mean amplitudes on adjacent channels can change radically between successive bursts. The correlation noted between "fading" and spectral change suggests that the fading may result from an interference phenomenon, such as scintillation produced by an irregular refracting screen. For moderate source velocities (30 km/sec) fast scintillations, if they occur, must be caused by refractive irregularities near the source, and possibly associated with it, and a model has been proposed, based on this idea, leading to the prediction of fine spectral structure in the low-frequency fluctuations. There is an apparent difficulty, however, in interpreting the present results in terms of scintillations, in that the onset times of the fluctuations appear to agree well over the whole observed frequency range, whereas variability would be expected. The work of Scott and Collins (Nature 218: 230(1968)) is discussed. (UK)

1103 ORIGIN OF PULSAR RADIATION. Stevens, K. W. H. (Univ. of Nottingham, Eng.). Nature (London), 220: 357-8 (Oct. 26, 1968).

It is stated that some recent developments in the theory of the propagation of electromagnetic waves through resonant media may have a bearing on the origin of pulsars. Supposing that, in space, there is a cloud of gas which is so far disturbed from thermal equilibrium that conditions are right for laser action to occur. It is then to be expected that coherent radiation will be emitted with a variety of frequencies, determined by the excitation of the gas. Supposing also that as this radiation travels away it passes through regions containing the same gas, but which is less excited, and possibly in thermal equilibrium. The atoms of this gas will have resonances at frequencies present in the laser output. Conditions may then be favorable for the radiation to break up into pulses. The theory demands solutions of nonlinear partial differential equations for which only certain solutions are as yet available. If the theory is applicable to pulsars it could result in the pulses being attributed to the properties of the intervening spaces rather than to the sources. (UK)

1104 DISTANCES TO PULSARS. Shuter, W. L. H.; Venugopal, V. R.; Mahoney, M. J. (Univ. of British Columbia, Vancouver). Nature (London), 220: 356-7(Oct. 26, 1968).

It has been argued that pulsars may be at distances considerably greater than the commonly assumed value of ~100 pc. The present communication describes observational evidence regarding the neutral hydrogen content in the directions of the first five known pulsars which supports this view. On July 26, 1968, 21-cm line profiles were obtained using the 25.6-m antenna of the Dominion Radio Astrophysical Observatory at Penticton, together with a new spectral line receiver, and the neutral hydrogen content was determined from these profiles. Results are tabulated for CP 0834, 0950, 1133, 1919, and HP 1506, indicating distances, except for CP 1919, varying from 160 to 935 pc. The case of CP 1919 appeared exceptional. (UK)

1105 MAGNETIC MODELS OF PULSARS. Ginzburg, V. L.; Zheleznyakov, V. V.; Ziatsev, V. V. (Lebedev Inst. of Physics, Moscow). Nature (London), 220: 355-6(Oct. 26, 1968).

In the absence of a stellar magnetic field, radial pulsations of a star lead to nonpolarized radiation. Observations of strong polarization caused consideration of models of pulsating magnetic white dwarfs. Even small fields (~10 to 100 oersteds) have radical effects on the movements of particles and the propagation of waves in a stellar atmosphere; the "stellar wind" from a magnetic star can come from the polar regions, and in the atmosphere of pulsating magnetic stars acceleration of particles must occur. When the field is regular some acceleration will take place as a result of magnetic pumping; if there are also irregular fields, cumulative acceleration may also be effective. The accelerated particles will fill the radiation belts of the star and come directly outwards from the polar regions to form two streams, for a dipole field. The particles will also be "poured" out of the radiation belts in subpolar regions. Three models are discussed in this communication. In the first model streams of rapid particles come from the polar regions, and at each pulse a shock wave ejects from the atmosphere of the star, into the stream, a "cold" plasma; in such a "stream-plasma" system plasma waves are generated, producing radio waves emitted from the polar regions. The relevance of

pulsars to the problem of the origin of cosmic rays is considered, and it is concluded that there are no good grounds for considering pulsars to be an effective source of galactic cosmic rays. In the second model, under the action of shock waves, particles from the radiation belt are poured out in subpolar regions resembling auroral zones. In these regions a sharp nonequilibrium velocity distribution of high-energy electrons occurs, with the resulting generation, in the atmosphere of the star, of plasma waves and radio waves. In the third model the radio emission is generated at the front of the shock wave as a result of the excitation of plasma waves and their transformation into radio waves. In the presence of the magnetic field collisionless shock waves will excite intensive plasma waves only for quasi-transverse propagation across the magnetic field, that is, only in the equatorial region. Because of this it is possible to explain, in principle, polarization of the radiation. Separation of pulses into two subpulses is accounted for by the presence of two emitting regions (the two poles). Another feature is pulse splitting, produced by the structure of a collisionless shock wave. Analysis of the polarization allows the finding of some criteria which characterize the magnetic field and plasma density in the region of pulsations and in the vicinity of the star. (UK)

1106 SECOND PERIODIC PULSATION IN PULSARS. Drake, F. D.; Craft, H. D. Jr. (Arecibo Ionospheric Observatory, Puerto Rico). Nature (London), 220: 231-5(Oct. 19, 1968).

It is stated that the pulses from pulsating radio sources seem to be made up of two subpulses; slow, class 1, and fast, class 2. (auth) (UK)

1107 TEMPERATURES AND CHEMICAL ABUNDANCES IN H II REGIONS, PLANETARY NEBULAE, AND NUCLEI OF GALAXIES. Peimbert-Sierra, Manuel. Berkeley, Calif., Univ. of California, 1967. 112p.

A photoelectric study of three H II regions—the Orion Nebula, M 8, and M 17—, three planetary nebulae—IC 418, NGC 6572, and NGC 6803—, and four galaxies—M 31, M 32, M 51, and M 8 M 81—has been undertaken with the Crossley and the 120" telescopes of the University of California. The effect that spatial temperature fluctuations have on electron temperatures and chemical abundances determined from H II regions and planetary nebulae was studied. Forbidden-line temperatures were obtained from: M 8, M 17, IC 418, NGC 6572, NGC 6803, and three points of the Orion Nebula. The Balmer Continuum was measured in: IC 418, NGC 6572, and three points of the Orion Nebula. The oxygen- and nitrogen-to-hydrogen abundance ratios in the three H II regions were found to be very similar to the solar values. On the other hand, the nitrogen-to-hydrogen abundance ratios in the three planetary nebulae were found to be over-abundant by factors of 2.5, 4, and 7 with respect to the solar value. From the [O I], [O II], [O III] line intensities it was found that collisions by thermal electrons are not responsible for the ionization in M 81 and M 51. The radiation field needed to explain the intensity of Hα in M 51 and M 81 was computed for three black-body temperatures. Large density fluctuations were found in the nuclei of M 51 and M 81 by comparing the Ne(λ3727) density with the Ne(rms) density. From the intensity of the [O I] line λ6300, it was found that a large fraction of the material in these nuclei is in the neutral form. It was established that solar abundances cannot explain the relative line intensities in the nuclei of M 51 and M 81. Several arguments are presented which suggest an overabundance of nitrogen in the nuclei of both galaxies. From these arguments it was concluded that most of the variation of the N II/Hα intensity ratio from spiral arms to nuclei of galaxies is due to a change of chemical abundances and not to a change of electron temperature. By assuming that the oxygen-to-hydrogen abundance ratio is solar, temperatures between 6000 and 7000°K were obtained; these values are typical for H II regions. (TSS) (Diss. Abstr.)

1108 A SEARCH FOR GAMMA-RAY LINE EMISSIONS FROM THE CRAB NEBULA. Jacobson, Allan Stanley. San Diego, Calif., Univ. of California, 1968. 129p.

An x-ray telescope was designed, incorporating one of the newly developed lithium-ion drifted germanium crystals as the main detector. This instrument, which has better energy resolution properties than any detector operated previously in the energy range of 20 to 250 keV, was used to study the spectrum of the Crab Nebula, and particularly to search for any fine spectral features such as line structures. The detector, with an area of 9.2 cm^2 and a solid angle of 0.077 steradians, was surrounded by a CsI(Tl) scintillation shield connected in electrical anticoincidence. The telescope was carried to an altitude of about 129,000 feet (3.2 gm/cm^2) by a 6-million cubic foot balloon. New upper limits are set on the three most intense lines in the 20- to 250-keV interval which are predicted to result from the r-process. The lines are at 60, 104, and 180 keV, with upper limits of 1.4×10^{-3}, 1.0×10^{-3}, and 1.1×10^{-3} photons/cm^2-sec, respectively. A possible line structure was found at 224 ± 3 keV, with an intensity of 6.6×10^{-3} photons/cm^2-sec. This line is about 3 σ above the continuum and because of statistical arguments must await confirmation by some future experiment before its existence can be definitely established. (TSS) (Diss. Abstr.)

1109 THE STRUCTURE AND PROPERTIES OF H II REGIONS. Rubin, Robert Howard. Cleveland, Case Western Reserve Univ., 1967. 89p.

The equations of ionization and thermal equilibrium are solved for gaseous nebulae, allowing for an arbitrary density distribution. It is shown, by solving the transfer equation for the ionizing radiation produced by recombinations, that use of the "on-the-spot" approximation (Zanstra 1951) can cause considerable errors in the temperature structure (up to ~2000°K near the nebular center) and predicted emission properties. In some cases, certain of the far-infrared forbidden lines of the cooling ions undergo considerable self-absorption. The implications of optical thickness are considered for two of these lines, [O III] 88 μ and 52 μ, by solving the line transfer problem. It is found that under certain conditions electron temperatures may be raised by up to 500 to 1000°K. The inclusion of density fluctuations is found to drastically reduce the ionized region and to raise somewhat the electron temperatures, all other parameters of the model being the same. Changes in the gas structure due to variations of the model parameters are investigated. For the models calculated, the emission properties of the important lines are presented. Temperature structures inferred from various forbidden line ratios of surface brightness, obtained from a model, are significantly different from each other and from the actual temperature structure. (Diss. Abstr.)

1110 A RADIO EMISSION FROM PLANETARY NEBULAE OBSERVED WITH THE PENCIL BEAM OF THE "NORTHERN-CROSS" RADIOTELESCOPE. Ficarra, A.; Padrielli, L. (Univ., Bologna). Nuovo Cim., 57B: 478-84(Oct. 11, 1968).

Thirteen planetary nebulae were observed with the Bologna Northern-Cross radiotelescope at a frequency of 408 MHz with the resolving power of 3 × 10 min of arc. The observations were conducted by using, for the first time, the pencil beam resulting from the correlation of both the E−W and the N−S arms of the radiotelescope. The most important result of this research is that we can now confirm that all the nebulae observed at radiofrequency show a thermal spectrum. (auth)

1111 OBSERVATIONS OF 4C SOURCES AT 408 MHz. Colla, G.; Fanti-Giovannini, C.; Fanti, R.; Ficarra, A.; Formiggini, L.; Grueff, G. (Univ., Bologna). Nuovo Cim., 57B: 427-36 (Oct. 11, 1968).

520 4C sources were observed with the E−W arm of the Bologna "Northern-Cross" radiotelescope, at a frequency of 408 MHz with the resolving power of (4 × 100) minutes of arc. The main purpose of this work was to study the dependence of the mean spectral index on the flux. The observed sources represent about 90% of the 4C sources in the region between δ = +30° and δ = +40° and are a homogeneous sample. The omitted 4C sources were lost either because of the presence of the Galaxy or because of random external interferences. (auth)

1112 THE BREAK IN THE RADIO EMISSION SPECTRUM OF CASSIOPEIA A. Malumyan, V. G. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 65-6(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 128-31(1966).

Near the frequency 30 Mc the spectral exponent of the radio emission from Cas A changes sign and the flux density at this frequency is a maximum. The two most probable mechanisms for explaining the break in the spectrum are discussed. (W.D.M.)

1113 POSSIBILITY OF A CHANGE IN THE INTENSITY OF THE RADIO EMISSION FROM GALACTIC SOURCES. Sanamyan, V. A. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 62-4(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 124-7(1966).

It is known that during the expansion of a nebula its magnetic field decreases. As a result, there is a decrease in the density of nonthermal radio emission. The question arises as to how the flux of radio emission from a nebula changes if its expansion occurs in a single dominant direction. This note presents a qualitative consideration of this problem. (W.D.M.)

Solar Phenomena

Refer also to abstract 1227.

1114 (N-68-25666) SOLAR X-RAY AND RADIO EMISSIONS FROM THE SUN. Ghosh, S. N. (Michigan Univ., Ann Arbor. High Altitude Engineering Lab.). Mar. 1968. Contract NASr-54(05). 21p. (NASA-CR-95061). CFSTI.

Assuming a Maxwell distribution of electron velocities in the solar corona, the x-ray fluxes at the Earth for temperatures 7×10^5, 1×10^6, 1×10^7, and 1×10^8°K were calculated for free–free transitions. These temperatures correspond to typical cases of completely quiet, quiet, active, and flare conditions of the Sun. The fluxes were then compared with those for free–bound transitions and line emissions obtained by Elwert and Kawabata. It is shown that during flares, the radiations are emitted primarily by free–free transitions, and that coronal temperatures and electron densities during different types of flares can be precisely determined from observations of solar x-ray emissions. For other conditions of the Sun, line emissions predominate, and the spectrum becomes harder and the flux increases as the Sun passes from the quiet to active condition. The emission of radio waves by free–free transitions for different conditions of the Sun was also calculated and it is shown that the calculated flux for T = 1.10^{6}°K and $n_e = 10^9$ cm^{-3} is the mean of the observed value for the quiet Sun. (auth) (STAR)

1115 (N-68-25734) DETERMINATION OF THE CORONAL MAGNETIC FIELD AND THE RADIO EMITTING ELECTRON ENERGY FROM A TYPE 4 SOLAR RADIO BURST. Ramaty, Reuven; Lingenfelter, Richard E. (California Univ., Los Angeles). May 1968. 35p. (NASA-TM-X-63234; X-611-68-208). CFSTI.

The intensity and frequency spectrum of gyro-synchrotron emission from energetic solar electrons radiating in coronal magnetic fields are calculated. These calculations based on a recent study of the generation of gyro-synchrotron emission in a magnetoactive plasma, are applied to a type-IV radio burst originating at a high altitude in the solar corona. It is shown that the observed frequency spectrum of the burst, which exhibits very sharp low- and high-frequency cutoffs, can be best understood in terms of gyro-synchrotron emission in an ionized medium and that from the observed frequency spectrum and the ambient coronal density it is possible to deduce both the magnetic field at the site of the emission and the range of electron energies responsible for the burst. (auth) (STAR)

1116 (N-68-25880) POLAR CAP ABSORPTIONS AND ASSOCIATED SOLAR TERRESTRIAL EVENTS THROUGHOUT THE 19th SOLAR CYCLE. Hakura, Yukio (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1968. 28p. (NASA-TN-D-4473). CFSTI.

Solar cycle variations in the emission of high-energy particles from the Sun were examined, by using daily polar cap absorption (PCA) indices, selected solar–terrestrial events, and satellite observations of low-energy solar protons. A close relationship between PCA's and type-IV solar radio outbursts existed throughout the last solar cycle. The solar corpuscular activity showed three peaks in 1957, 1960, and 1963. The first peak was characterized by a random occurrence of type-IV outbursts, PCA's, and geomagnetic SSC's (geomagnetic storms with sudden commencement). Active centers were restricted in two parts of narrow heliographic longitudes during the second, the most prominent peak, giving a slight 27-day recurrence to the corpuscular activity. Finally, a pronounced peak of 27-day recurrence appeared during the third period. A recurrent series of solar MeV protons lasted 15 solar rotations, while those of geomagnetic Kp index and galactic cosmic-ray intensity lasted 25 rotations. (auth) (STAR)

1117 THEORY OF FLARES AND SOME RELATED SOLAR PHENOMENA. Unsoeld, Albrecht. Quart. J. Roy. Astron. Soc., 9: 294-307(Sept. 1968).

With a view to understanding the mechanism of solar flares the energy transfer in the quiet solar atmosphere was studied. The stationary phenomena of faculae, plages, and coronal condensations were also studied. It is shown that flares are closely related to plages and white flares to faculae. It is also shown that flares cannot be due to some sort of magnetohydrodynamical instability, as has been previously supposed, and it is proposed that flares are nonstationary phenomena corresponding to plages and faculae, not only as to their height in the solar atmosphere and their relations to centers of activity, but also as to their physical mechanism. (UK)

1118 COSMIC-RAY INTENSITY INCREASE ON JANUARY 28, 1967. Sud, L. V. (Univ., Mayor de san Andres, La Paz, Bolivia). Aust. J. Phys., 21: 755-9(Oct. 1968).

Ground-based cosmic-ray detectors have so far recorded two increases in the intensity of cosmic rays. The first one was observed on July 7, 1966, and the other on Jan. 28, 1967. Both these events are described and their unusual characteristics are pointed out. (W.D.M.)

1119 MAGNETIC FIELDS IN TWO ACTIVE PROMINENCES. Malville, J. McKim (High Altitude Observatory, Boulder, Colo.). Solar Phys., 5: 236-9(Oct. 1968).

The strongest magnetic field measured in a prominence during the 1964–66 observing seasons at Climax was detected in an active prominence on the west limb on Sept. 19, 1966. At one location the longitudinal component of the field was found to be -80 ± 6 gauss. No field above the noise level was detected at other locations. On Dec. 10, 1966, an east-limb prominence experienced an activation in association with an importance-2 limb flare. Magnetograms of this prominence obtained 7 hr prior to the activation showed a magnetic field of $+25 \pm 2$ gauss at three positions. Several interpretations of the Dec. 10 observations are suggested. (A.G.W.)

1120 CAPE LYOT Hα–HELIOGRAPH RESULTS: AN ANALYSIS OF FLARE ACTIVITY 1958-65. Reid, John H. (Lockheed Electronics Co., Houston, Tex.). Solar Phys., 5: 207-35(Oct. 1968).

The Lyot Hα heliograph at the Royal Observatory, Cape of Good Hope, was in almost daily operation from March 12, 1958, to December 31, 1965. From the records obtained, a definitive list of 2907 flares was compiled, their properties were analyzed, and the results are presented herein. The data on east–west distribution of activity, although inconclusive, show an asymmetry of flare activity with 56.5% of the flares west of the central meridian; this is partially due, however, to an inhomogeneous density distribution in the filtergrams. Flare distribution with respect to heliographic longitude, association with spot types, and number of spots in the group are also discussed. The frequency of flare areas, rise times, and durations are examined as is their relationship to distance from the disk center. (auth)

1121 STUDY OF THE LOCALIZATION OF FLARES IN THE EVOLVING MAGNETIC PATTERN OF SOLAR ACTIVE REGIONS. Martres, M.-J. (Observatoire de Paris, Meudon, France); Michard, R.; Soru-Iscovici, I.; Tsap, T. T. Solar Phys., 5: 187-206(Oct. 1968). (In French).

From the material of exceptional completeness collected for the "Cooperative Study of Solar Active Regions," an attempt is made to define the spatio-temporal conditions of flare occurrence inside the evolving magnetic structure of active regions (A.R.). To describe the evolution of the magnetic pattern of an A.R. the concept of "evolving magnetic feature" (SME, from the French equivalent "Structure magnetique evolutive") is introduced; it is a patch of field of a given polarity, generally bound by a closed "isogauss" of longitudinal field, which appears, evolves, and disappears during the life of the A.R. These SME have characteristic sizes of 10^4 to 10^5 km and may contain sunspots or not. The following laws are established: (1) Flares at their beginning are localized on two (or more) SME of opposite polarities; this result was already known. (2) Of the two SME of opposite polarities that take part in the flare, one is increasing, the other decreasing in area (and magnetic flux). With the help of these laws it was possible to predict the spatio-temporal location of the majority of flares occurring in a large A.R. observed during September 1965. (auth)

1122 ABUNDANCE OF CHLORINE IN THE SUN. Lambert, D. L.; Mallia, E. A. (Univ. Observatory, Oxford). Solar Phys., 5: 181-6(Oct. 1968).

The Cl I line λ 8375.943 ($4s^4P_{\frac{5}{2}} - 4p^4D^0_{\frac{7}{2}}$) is identified in the solar spectrum. This is the first identification of a chlorine line in the solar spectrum. The measured equivalent width ($W_\lambda = 0.8$ mÅ) corresponds to an abundance log N(Cl) = 5.65 on the scale log N(H) = 12.00. (auth)

1123 SOLAR ABUNDANCES OF LITHIUM, BERYLLIUM, AND BORON. Grevesse, Nicolas (Univ., Liege). Solar Phys., 5: 159-80(Oct. 1968).

New solar abundances have been derived for Li, Be, and B. They are mainly based on high-resolution spectra obtained at the Jungfraujoch Scientific Station (Switzerland). For Li, the abundance results from a discussion of the photospheric and sunspot spectra. The results, log $N_{Li} = 0.42$, log $N_{Be} = 1.17$, and log $N_B < 2.80$ (in the log $N_H = 12.00$ scale), are lower than the previously admitted abundances for these elements. The far-uv spectrum ($\lambda < 3000$ Å) has also been considered in each case. The meaning of the results is discussed from the point of view of the destruction of these elements during the evolution of the Sun. (auth)

1124 SPECTRAL OBSERVATIONS OF SPICULES AT TWO HEIGHTS IN THE SOLAR CHROMOSPHERE. Pasachoff, Jay M. (Harvard Univ., Cambridge, Mass.); Noyes, Robert W.; Beckers, Jacques M. Solar Phys., 5: 131-58(Oct. 1968).

An observational program at the Sacramento Peak Observatory in 1965 provided high-dispersion spectra of the solar chromosphere in several spectral regions simultaneously. These regions included various combinations of the spectral lines Hα, Hβ, and Hε, the D_3 line of He I, the infrared triplet of O I, and the H and

K lines and the infrared triplet of Ca II. With the use of an image slicer the observations were made simultaneously at two heights in the solar chromosphere separated by several thousand kilometers. From these data the following conclusions are drawn: (a) Emission of different lines arises in the same chromospheric features. The intensity ratio of lines of different elements varies significantly from spicule to spicule. For the H and K lines of ionized calcium, this ratio remains constant, independent of wavelength throughout the line, overall intensity, and height in the chromosphere. Two rare-earth lines in the wing of the H line show no spicular structure at all. (b) The line-of-sight velocities of many features reverse as a function of time, although most spicules show velocities in only one direction. The simultaneous spectra at two heights show most spicules to have the same line-of-sight velocity at both. There may be an additional class of features, mostly rapidly moving, whose members have line-of-sight velocities that increase with height. These features comprise perhaps 10% of the total. Velocity changes occur simultaneously, to within 20 sec, at two heights separated by 1800 km, indicating velocities of propagation of hundreds of km/sec. The velocity field of individual features is often quite complicated; many spectral features are inclined to the direction of dispersion, implying that differential mass motions are present. (c) The existence of anomalously broad H and K profiles is real. Even with high dispersion and the best seeing, such profiles are not resolved into smaller features. The central reversal in K, H, and Hα appears to remain unshifted when the wings are displaced in wavelength, indicating that the reversal is nonspicular. (auth)

1125 INFLUENCE OF A SOLAR ACTIVE REGION ON THE INTERPLANETARY MAGNETIC FIELD. Schatten, Kenneth H. (Univ. of California, Berkeley); Ness, Norman F.; Wilcox, John M. Solar Phys., 5: 240-56(Oct. 1968).

The interplanetary magnetic field has been mapped between 0.4 and 1.2 au in the ecliptic plane, extrapolating from satellite measurements at 1 au. The structure within sectors and the evolution of sectors are discussed. The development of a solar active region appears to produce magnetic loops in the interplanetary medium that result in the formation of a new sector. (auth)

1126 PLASMA OBSERVATIONS ON EXPLORER 34. Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.); Burlaga, L. F.; Wilkerson, T. D. J. Geophys. Res., 73: 6809-24(Nov. 1, 1968).

Results of the Explorer 34 plasma detector obtained during three magnetic storms, May 30, June 5, and June 25, 1967, are discussed. Detailed comparisons with magnetic field observations on the same satellite are used to interpret the observations and to identify shocks and tangential discontinuities. A relation between the magnitude of such sudden changes in the Earth's magnetic field and the solar-wind parameters has been derived by Siscoe. These observations are consistent with this relationship. The local shock speeds are derived from data obtained at the time of the sudden commencements. An example of an si^+ si^- pair is discussed, and in this case the negative impulse is shown to be due to a tangential discontinuity rather than a shock, whereas the positive impulse is associated with a shock. Helium observations are described that show that during the main phase of some geomagnetic storms the abundance ratio n_α/n_p shows a marked increase. In the May 30 storm it attained a value of 0.15 ± 0.02, $5\frac{1}{2}$ hours after the sc, an increase of seven times over the value observed earlier. (auth)

1127 CORRECTED ABSOLUTE FLUX OF THE JULY 7, 1966 SOLAR X-RAY FLARE. Van Allen, J. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 73: 6863(Nov. 1, 1968).

Due to a mutual normalization of the 3 x-ray detectors on Explorer 33 and a similar one on Explorer 35 using flight data, the absolute fluxes in an earlier paper (Van Allen, 1967) must be multiplied by a factor of 5.8. (W.D.M.)

1128 DISCUSSION OF PAPER BY K. V. S. K. NATHAN AND J. A. VAN ALLEN, 'DIFFUSION OF SOLAR COSMIC RAYS AND THE POWER SPECTRUM OF THE INTERPLANETARY MAGNETIC FIELD.' Jokipii, J. R. (Univ. of Chicago). J. Geophys. Res., 73: 6864-6(Nov. 1, 1968).

Nathan and Van Allen [1968] made the suggestion that observations of 40-keV electrons and 75-MeV protons during a solar flare event yield important information concerning the structure of the interplanetary field. Their approach is useful since it avoids many of the difficulties in the theoretical understanding of the propagation process. In particular, since the time histories of the two species of particles are observed to be similar, they point out that the diffusion coefficient must depend only on particle velocity over a wide range of magnetic rigidities and be approximately independent of rigidity between R = 0.15 Mv and R = 300 Mv. It is the purpose of this note to point out some inaccuracies in their discussion of diffusion and the magnetic field power spectrum and to suggest a possible alternative conclusion concerning the power spectrum. (W.D.M.)

1129 INITIAL RESULTS OF THE PIONEER 8 VLF ELECTRIC FIELD EXPERIMENT. Scarf, F. L.; Crook, G. M.; Green, I. M.; Virobik, P. F. (Space Sciences Lab., Redondo Beach, Calif.). J. Geophys. Res., 73: 6665-86(Nov. 1, 1968).

The Pioneer 8 spacecraft was launched into an outbound heliocentric orbit on December 13, 1967. The payload includes a simple vlf electric field detector that uses the 423-MHz antenna supplied for the Stanford radio propagation experiment. Broadband signals in the frequency range 0.1 to 100 kHz were examined by performing a pulse height analysis of the waveform, and wave amplitudes were also measured in bandpass channels centered at 0.4 and 22 kHz. It was found that low-frequency electric field oscillations can always be detected in the solar wind, and that the amplitudes vary with changing interplanetary conditions. Large-amplitude high-frequency noise bursts are also detected sporadically, and these were identified as electron plasma oscillations in the solar wind. (auth)

1130 SOLAR EXTREME LIMB SPECTRUM OF THE RARE EARTH CERIUM. Canfield, Richard Charles. Boulder, Colo., Univ. of Colorado, 1968. 153p.

In this thesis observations and theoretical calculations demonstrate that noncoherent scattering quantitatively explains the observed behavior of rare-earth lines. The six Ce II solar spectral lines observed span the wavelength range λλ4000 to 4700 A. The photographic and photoelectric observations, made with the 160-cm aperture, 90-m-focal-length McMath solar telescope, cover the solar disk from its center to beyond the limb. Strong evidence demonstrates that of all available mechanisms for explaining the behavior of the rare earth lines in the solar spectrum, only a considerable contribution from noncoherent scattering can explain the observed phenomena in terms of the currently understood properties of radiation transfer and the solar atmosphere. (TSS)

1131 THEORETICAL SUNSPOT MODELS. Yun, Hong Sik. Bloomington, Ind., Indiana Univ., 1968. 168p.

Thirty-two theoretical sunspot models were computed using as parameters the effective temperature, total magnetic flux, and angle of inclination at the outer edge of the penumbra. The bottom of the spot was taken in each to be 1.056×10^9 cm below $\tau = 2/3$ in the normal photosphere. The detailed structure of each computed model is described by a list of the run of the physical variables with depth. The physical properties of each model are discussed and compared with the observation to select these models which represent the observations best. (TSS) (Diss. Abstr.)

1132 INFRARED OBSERVATIONS OF THE OUTER SOLAR CORONA. MacQueen, Robert Moffat. Baltimore, Johns Hopkins Univ., 1968. 144p.

The 2.2-μ wavelength infrared outer solar corona was observed in two experiments: first, employing a ground-based telescope from a high-altitude site near Pulacayo, Bolivia, during the 93-second totality of the eclipse of November 12, 1966; and second, employing a stratospheric balloon package with an infrared coronagraph flown to an altitude of 28 km, during a 5.25-hour period, on January 9, 1967. The design and evaluation of the infrared balloon-borne coronagraph is discussed in detail, and the various origins of stray light investigated. The completed flight coronagraph was found to introduce a stray radiance of less than $3 \times 10\ 10^{-12} B_\odot$, where $B_\odot$ is the radiance of the mean solar disk at wavelength 2.2 μ. During eclipse the corona was observed from $2R_\odot$ to $6R_\odot$ in the ecliptic plane, and at a single point perpendicular to the ecliptic at $5R_\odot$. Balloon observations covered the range $3.7R_\odot$ to $10R_\odot$, at position angles from 20° north to 40° south of the ecliptic, on the east limb of the Sun. Features attributed to the vaporization of interplanetary material were observed at $3.5R_\odot$, $4R_\odot$, $8.7R_\odot$ and $9.2R_\odot$, the former two during the period of totality, and the latter three during the balloon observations. The electron scattered coronal component was eliminated through the use of the results of prior workers; and possible interpretation of the resultant coronal deflections in terms of an infrared F corona, and thermal emission of coronal dust, is given. Consideration of the thermodynamics and supposed dynamics of the particles lends support to the F-coronal origin of the observed continuum corona. The plane of symmetry of the outer corona was found to coincide closely with the invariable plane of the solar system; this result, and the observation of the thermal features, are discussed with respect to the question of a major geocentric contribution to the observed coronal radiance. Finally, implications of limited observations of the stratospheric sky radiance at wavelength 2.2 μ are discussed, and an approximate eddy-diffusion coefficient over the region 25 to 28 km deduced from these observations, and those of prior workers. (Diss. Abstr.)

1133 A STUDY OF NEUTRAL ATOMIC OXYGEN IN THE SOLAR ATMOSPHERE. Altrock, Richard Charles. Boulder, Colo., Univ. of Colorado, 1968. 235p.

This study investigates possible departures from local thermodynamic equilibrium (LTE) in photospheric oxygen and derives an abundance for that element. The only previous studies indicating photospheric non-LTE effects were those of Pecker. The observations were obtained with the 16-inch Coudé coronagraph and the 13-meter Littrow spectrograph of Sacramento Peak Observatory. (TSS) (Diss. Abstr.)

1134 KINETIC THEORY OF THE SOLAR WIND AND ITS INTERACTION WITH THE MOON. Griffel, David Henry. Pasadena, Calif., California Inst. of Tech., 1968. 122p.

Beyond about 0.1 au from the Sun, fluid mechanics is not a good approximation for the solar wind, because the collision frequency is low. Analysis of the particle dynamics shows that if there are not collisions beyond 0.1 au, then at the earth $T_{||}/T_{\perp} = 35$; this is much greater than is observed. The effects of interactions were studied by means of the Boltzmann equation. Solving it with Krook's collision term, it was found that the temperature anisotropy observed by the Vela satellite requires each particle to make an average of 2 or 3 collisions between 0.1 and 1 au. The temperature averaged over direction roughly follows an adiabatic law, with $\gamma = 3/2$; γ tends to increase with distance. The theory predicts an excess of high-velocity particles, as is observed by Vela, even when the collision frequency is independent of velocity; but to produce an effect as strong as that observed requires a fairly strong velocity-dependence of the collision frequency. The interaction of the wind with the Moon, treated as a solid body, with neither magnetic field nor atmosphere, absorbing and neutralizing all incident particles was studied. Two-dimensional models of the complete wind-planet interaction were studied and it is shown that in any steady two-dimensional flow, the plasma velocity must be tangential to the body. (TSS) (Diss. Abstr.)

Galaxies

1135 A CONTINUUM SURVEY OF THE SOUTHERN MILKY WAY AT 1410 MHz. Hill, E. R. (Commonwealth Scientific and Industrial Research Organization, Epping, New South Wales). Aust. J. Phys., 21: 735-7(Oct. 1968).

This paper presents a contour map of the Southern Milky Way at 1410 MHz obtained using the 210 ft radio telescope at Parkes. (auth)

1136 OBSERVATIONS OF INTERSTELLAR REDDENING. IV. RESULTS FOR THE REGION IN CEPHEUS. Nandy, K. (Royal Observatory, Edinburgh). Mon. Notic Roy. Astron. Soc., 140: 551(1968).

The interstellar extinction law in the direction of Cepheus was investigated from measurements of objective prism spectra, and the results are compared with the photoelectric observations of O stars made by Rodgers (1961) and Whiteoak (1966). (UK)

1137 RECENT RENAISSANCE OF OBSERVATIONAL COSMOLOGY. Sciama, D. W. (Cambridge Univ., Eng.). Phys. Bull. (London), 19: 329-36(Oct. 1968).

A brief introductory survey of the historical development during the last fifty years of observational cosmology is followed by a discussion of the detection of objects with extremely large red shifts under the headings: radio source counts, quasar counts, and intergalactic medium. Topics which relate to the existence of cosmic black-body radiation are discussed and include the thermal history of the Universe; the helium problem; astrophysical effects of the black body radiation; the peculiar velocity of the Earth; the isotropy of the Universe; the homogeneity of the Universe; and singularities in the Universe. (UK)

1138 SEARCH FOR X RAYS FROM THE LARGE AND SMALL MEGALLANIC CLOUDS. Lewin, W. H. G.; Clark, G. W.; Smith, W. B. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 220: 249-50(Oct. 19, 1968).

From a high-energy x-ray sky survey carried out in a balloon flight from Mildura, Australia, on Oct. 24, 1967, upper limits of one-twelfth and one-eighth the intensity from Tau X-1 were determined for intensities from the Large and Small Magellanic Clouds, respectively. The experimental procedure is described. No evidence was found for discrete sources. The upper limits on the x-ray energy flux between 20 and 52 keV from the Large and Small Clouds were $\sim 0.6 \times 10^{-9}$ and $\sim 0.9 \times 10^{-9}$ ergs/cm^2/sec, respectively, assuming spectra like that of Tau X-1. The upper limits in the 52- to ~110-keV energy range for both Clouds were $\sim 10^{-9}$ ergs/cm^2/sec. (UK)

1139 INTERGALACTIC HYDROGEN IN THE VIRGO CLUSTER OF GALAXIES. Allen, R. J. (Observatoire de Paris, Meudon, France). Nature (London), 220: 147-8(Oct. 12, 1968).

Evidence for the existence of intergalactic atomic neutral hydrogen was advanced by Koehler and Robinson (1966) from absorption effects in the continuum radio spectra of Fornax A, 3C 273, and Virgo A near 21-cm wavelength. For Virgo A these authors observed a Gaussian absorption profile centered at a radial velocity of +1,200 km/sec, with an optical depth of $59 \pm 3 \times 10^{-4}$ and a full width at half power of 920 km/sec. The present communication states that this measurement is negated by recent observations with the large radio telescope at Nançay, and that the upper limit for the amplitude of a Gaussian profile of the form reported is 2×10^{-3}, which is one-third of Koehler and Robinson's result. The problem in this type of measurement is stated to be the obtaining of a proper calibration of the chromatic effects in the receiving system, and important precautions are indicated. A blackbody reference radiator was employed, in order to obtain "absolute spectral measurements." Difference spectra obtained for the Moon and for Virgo A are shown. The model for Virgo A at 21 cm is an unresolved core containing 60% of the total flux, and a halo $10' \times 8'$ in angular size, both having flux density spectral indices of 0.8. The measurements covered only the central part of the absorption profile reported by Koehler and Robinson. Some interesting applications of the possibility of making accurate spectral index measurements over small percentage bandwidths are briefly discussed. (UK)

1140 A MODEL FOR THE EXPLOSION IN M82. Solinger, Alan Benjamin. Ann Arbor, Mich., Univ. of Michigan, 1968. 87p.

Analysis of the relevant radio and optical data shows that a synchrotron interpretation of the polarized optical continuum observed at large distances from the center of M82 should be ruled out. It is shown that the Hα emission from the filaments is collisionally excited, and that a blast-wave interpretation of the explosion provides a suitable heating mechanism. The observed circular orientation of the electric vectors of the polarized light can be produced by scattering of light from the proposed Seyfert-like nucleus (located at the center of the explosion) by free electrons behind the shock front. (TSS) (Diss. Abstr.)

1141 DETAILED PHOTOMETRIC AND COLORIMETRIC STUDIES OF SIX SPIRAL GALAXIES IN VIRGO. Markaryan, B. E.; Oganesyan, E. Ya.; Arakelyan, S. N. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 21-38(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 53-80(1966).

Results are given for a detailed two-color photometric study of spiral galaxies NGC 4371, 4388, 4402, 4438, 4440, and 4501, situated in Virgo. The investigation was made using the method described in an earlier paper by the authors; this article may be considered a continuation of that work. Continuous brightness measurements (in blue and yellow light) of the galaxies made it possible to prepare detailed brightness and color distribution charts for them. The data from the charts were used in determining the integral brightnesses and colors of the galaxies. The results made it possible to define the principal characteristics of the structure of these galaxies. Among the investigated galaxies NGC 4402 and 4438 are of particular interest. A number of facts are presented indicating that the first of these is an irregular galaxy of the M 82 type and that the second is relatively young. (auth)

Cosmology

1142 AXI-SYMMETRIC ELECTROMAGNETIC RADIATION IN GENERAL RELATIVITY IN THE FIRST APPROXIMATION. Unt, V. (Inst. of Physics and Astronomy, Tallin, USSR). Izv. Akad. Nauk Est. SSR, Fiz. Mat., 17: 290-302(1968). (In Russian).

In this paper the integration of the Einstein equations in the first approximation (when electromagnetic radiation is present) is reduced to simple algebraic operations and to the integration of the ordinary differential equations. It is shown that the mass loss of the source is described by the real mass only in the case when the convergence conditions are satisfied. Physically speaking, these conditions represent a deflection of rays in the gravitational field of the mass transported by electromagnetic waves. The equations are integrated in the cases of the electromagnetic dipole and quadrupole radiation. (auth)

1143 STELLAR EVOLUTION AND NUCLEOSYNTHESIS. Reeves, Hubert. Documents on Modern Physics. New York, Gordon and Breach, Science Publishers, 1968. 110p. $6.50, Hardbound; $4.50, Paperback.

In this series of five lectures, an attempt is made to study stellar evolution and nucleosynthesis in detail, and to determine the individual role of each of the interactions of physics, then the role of various groups of elementary particles in stellar, nucleosynthetic, and galactic evolution. The lectures are titled: the role of the four fundamental interactions of physics in stellar

and galactic evolution; the role of charged particles; the role of gammas and neutrinos (the iron peak); the role of neutrons (heavy element synthesis); and the evolution of the galaxies (stellar statistics and cosmochronology). (W.D.M.)

1144 FORMATION OF GALAXIES IN CLASSICAL COSMOLOGY. Peebles, P. J. E. (Princeton Univ., N. J.). Nature (London), 220: 237-9(Oct. 19, 1968).

The possibility that galaxies may have arisen out of thermal fluctuations in early stages in the expansion of the Universe is discussed. (auth) (UK)

1145 RADIATION AND MATTER IN AN OPEN COSMOLOGICAL MODEL. Chernin, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Nature (London), 220: 250(Oct. 19, 1968).

The discovery of the cosmic background radiation has stimulated research on the cosmological model with both matter and radiation. As usually used, the Friedmann solutions correspond either to pressureless matter alone, or to radiation alone, and the equations describe an open model with negative curvature. It seems reasonable to consider an open model because of a number of observational and theoretical arguments. In this communication some properties of the analytical solution for the open cosmological model containing both radiation and matter are considered. The nonlinearity of cosmological equations is emphasized. Results favor an open cosmological model with matter density close to the average density of the visible matter due to galaxies. (UK)

1146 COSMOLOGY AND ELECTRODYNAMICS. Pegg, D. T. (Clarendon Lab., Oxford). Nature (London), 220: 154-5 (Oct. 12, 1968).

It is stated that the approach of Hoyle and Narlikar (Nature 219: 340(1968)) to quantum electrodynamics provides a good explanation of spontaneous radiation emission, and leads to an expression for the emission rate in agreement with the observed rate provided that the zero-point oscillations of the electrodynamic field are ignored. This communication discusses what position the zero-point oscillations hold. If they are not ignored in the Hoyle–Narlikar theory the predicted emission rate is one and a half times too great. The Einstein–de Sitter model is found to satisfy the necessary requirements and is allowable. (UK)

1147 PULSARS AND A POSSIBLE NEW TEST OF GENERAL RELATIVITY. Keswani, G. H. Nature (London), 220: 148 (Oct. 12, 1968).

Hoffmann (1968) suggested comparison of the frequency of terrestrial clocks and of signals from pulsars to test the prediction from general relativity theory relating to the effect on frequency of changing gravitational fields and motion. The present communication presents an amendment to Hoffmann's analysis, which employed an amalgamation of Newtonian and Einstein gravitational theories. It is stated to be desirable, and possible, to use only the general theory of relativity. The author employs the classical theory used in determining the advance of perihelion of Mercury. (UK)

1148 EMISSION AND ABSORPTION OF WAVES BY CHARGED PARTICLES IN MAGNETIZED PLASMAS. Melrose, D. B. (Yeshiva Univ., New York). Astrophys. Space Sci., 2: 171-235(Oct. 1968).

A semiclassical theory describing the emission and absorption of waves is applied to the interaction of charged particles with waves in magnetized plasmas. Spontaneous emission of all cold-plasma wave modes is calculated in detail. The method gives the absorption coefficient for the waves and a diffusion equation in momentum space for the particles describing the effects of the induced processes. Coefficients describing the systematic change of particle parameters follow from the diffusion equation. Applications of astrophysical interest are outlined. (auth)

1149 BRANS–DICKE COSMOLOGY. II. Greenstein, George S. (Yale Univ., New Haven). Astrophys. Space Sci., 2: 155-65(Oct. 1968).

The implications of the Brans–Dicke scalar-tensor theory for cosmology with particular emphasis on the primordial element abundances that would obtain are discussed. Two general classes of models are found. Models of one class expand through the nuclear burning stage slightly more rapidly than the general relativistic case: models of the other class may expand at any rate whatsoever. The first class of models yields primordial abundances of D, ^{3}He, and ^{4}He in agreement with their general relativistic values if the present mass density is low. High-density cosmologies, however, would produce too much ^{4}He. The second class of models yields element abundances which are far too high unless the expansion rate was quite large: in this case no ^{4}He at all is produced. Finally, the rate of change of the constant of gravitation G at the present epoch is determined. For all but a very small class of models G is negative at the present epoch. Models with positive values of G at the present epoch produce no primordial ^{4}He whatsoever, and have ages significantly lower than the corresponding general relativistic ages. (auth)

1150 GRAVITATIONAL INSTABILITY OF ANISOTROPIC HOMOGENEOUS SOLUTIONS. Doroshkevich, A. G. Astrophysics (Engl. Transl.), 2: 15-17(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 37-44(1966).

The gravitational instability of anisotropic models is briefly considered. It is shown that the amplification factor for the initial inhomogeneities in anisotropic models is considerably greater than in Friedmann models. The possibility of formation of cosmic bodies due to gravitational instability in anisotropic models is discussed. (auth)

1151 VIRIAL MASS-LUMINOSITY RATIO AND THE INSTABILITY OF DIFFERENT GALACTIC SYSTEMS. Karachentsev, I. D. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.), 2: 39-49(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 81-99(1966).

The virial mass–luminosity ratio f was determined for 87 pairs, 11 triple systems, 29 groups, and 15 clusters of galaxies. It was concluded that there is an increase in the mean degree of instability of systems as their luminosities increase. The virial mass–luminosity ratio was computed for the Metagalaxy. A relationship between instability of galactic systems and expansion of the Metagalaxy is indicated. (auth)

1152 POSSIBLE RELATION BETWEEN COSMOLOGICAL QUANTITIES AND THE CHARACTERISTICS OF ELEMENTARY PARTICLES. Alpher, Ralph A.; Gamow, George (General Electric Research and Development Center, Schenectady, N. Y. Univ. of Colorado, Boulder). Proc. Nat. Acad. Sci. U. S., 61: 363-6(Oct. 1968).

The time of equality of mass densities of matter and radiation in the expanding universe, when expressed in atomic time units, is found to be numerically equal to the ratio of electrical to gravitational forces between protons. Moreover, it is shown to be possible to obtain the value of the ratio of heat capacities of radiation to that of matter from this time of equality of densities and thence to relate to the ratio of forces between protons. Since the heat capacity ratio singles out a particular model of the universe, one then has a unique relation between quantities characteristic of the universe and of elementary particles. (auth)

Planetary Phenomena

1153 RECENT OBSERVATIONS OF SATURN, URANUS, AND NEPTUNE AT 3.12 CM. Berge, G. L. (California Inst. of Tech., Pasadena). Astrophys. Lett., 2: 127-31(Oct. 4, 1968).

During 1967 a large set of planetary observations was obtained at a wavelength of 3.12 cm using the two-element interferometer at the Owens Valley Radio Observatory. This paper presents the results of the unresolved measurements of Saturn, Uranus, and Neptune. All three planets were detected, and the equivalent black-body disk temperatures determined were 137° ± 12°, 158° ± 20°, and 115 ± 36°, respectively. No polarization was detected to within specified limits. (auth)

1154 ATMOSPHERIC PROPERTIES FROM THE INVERSION OF PLANETARY OCCULTATION DATA. Hays, P. B.; Roble, R. G. (Univ. of Michigan, Ann Arbor). Planet. Space Sci., 16: 1197-8(Sept. 1968).

Some of the properties of planetary atmospheres are summarized, such as refraction, microwave phase shift, attenuation (scattering particle absorption), and airglow emission, which may be obtained through the inversion of planetary occultation data. (UK)

1155 MEASUREMENTS OF THE PERTURBED-INTERPLANETARY MAGNETIC FIELD IN THE LUNAR WAKE. Taylor, Harold E.; Behannon, K. W.; Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 6723-35(Nov. 1, 1968).

Measurements of the interplanetary magnetic field in the vicinity of the Moon were made from lunar orbit on the Explorer 35 spacecraft. No shocks are observed in the vicinity of the Moon, either in front of the Moon or within 5.4 R_M behind the Moon. The interplanetary magnetic field appears to be convected past the lunar body without much distortion. A regular pattern of magnetic perturbations is observed when passing through the lunar wake. The perturbation amplitude is small and variable, typically less than 30% of the ambient interplanetary magnetic field. Simultaneous measurements made by Explorer 33 while in the interplanetary

medium but not in the lunar wake show that even sharp changes in the interplanetary magnetic field are found essentially undistorted in the lunar wake. These simultaneous measurements also help to identify the magnetic perturbation pattern in the wake region. (auth)

1156 INFLUENCE OF IO ON JOVIAN DECAMETRIC RADIATION. Shever, Izzydor. Gainesville, Fla., Univ. of Florida, 1967. 127p.

Thesis.

An analysis of the Jovian decametric radiation from 1957–1966 at three frequencies (15, 18, and 22 Mc) has shown the influence of Jupiter's innermost Galilean satellite, Io, on this radiation. For each year the study has reconfirmed that there are two zenocentric intervals of Io's position in which this influence is noted. This coordinate system is centered on Jupiter and has its origin at the position of Io's superior geocentric conjunction. In the 60 to 120° interval Io enhances the probability of reception from sources B_1 and B_2, and in the 210° to 270° interval it enhances the probability of reception from sources A and C. In addition, it was found that Io also influences the Jovian longitude positions of these sources. By merging the data of one frequency from all years it was found that for each source there is a distinct combination of an Io interval and an Earth interval in the Jovian longitude system for which the probability of reception is enhanced by Io. It was also shown that the Sun's position plays no important role either in modifying Io's zenocentric position for enhancing the radiation or in changing the Jovian longitude source positions. No short-term (less than five weeks) correlations between solar activity and Jovian activity were found; however, it was shown that the yearly changes in probability and source positions are more apt to be related to the sunspot cycle than to the yearly changes in the declination of the Earth as seen from Jupiter. A model of the Jovian decametric radiation is presented in order to demonstrate how Io could be influencing the probability of reception by changing the ray paths of this radiation. It is suggested that Io causes tides in the ocean of electrons of the Jovian magnetosphere. At certain times, when the decametric radiation passes through the bulges of these tides, the radiation is beamed toward the Earth. (Disser. Abstr.)

Atomic and Molecular Physics

Refer also to abstracts 111, 1092, 1508, 1567, 1577, 1740, 1881, and 1899.

1157 (JINR-P14-4052) MESIC ATOMS INTERACTING WITH THE MEDIUM AND THE μ^--MESON DEPOLARIZATION. Evseev, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1968. 15p. (In Russian). Dep.

It is shown that the divergences between the predictions of the existing μ^--meson depolarization theory and the experimental data can be eliminated by means of the account of the mesic-atom interaction with the medium after the end of the stage of the mesic-atom transition cascade. New experiments are suggested for the identification of different types of interaction of mesic atoms with the medium. (auth)

1158 (N-68-29879) BEHAVIOR OF THE IONIZATION CROSS SECTION IN HIGH-ENERGY ELECTRON-HYDROGENIC ATOM COLLISION. Omidvar, Kazem (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). July 1968. 27p. (NASA-TM-X-63288; X-641-68-294). CFSTI.

The ionization cross section per unit range of the energy ϵ of the ejected electrons for the collision of an incident charged particle of high energy E with an atomic system is given by $dQ/d_\epsilon = E^{-1}[A(\epsilon)/nE + B(\epsilon)]$, where A and B are functions of ϵ, and the total cross section is given by $Q = E^{-1}[A_T/nE + B_T]$. The coefficients $A(\epsilon)$ and $B(\epsilon)$ for the particular case of the atomic hydrogen are derived analytically as an expansion with respect to $k = \sqrt{\epsilon}$. The expansion converges for all values of k. The coefficients of the first two leading terms of the expansion of $dQ/d\epsilon$ with respect to ϵ or $1/\epsilon$ when ϵ is small or large is found. A relationship for the average energy of the ejected electrons is given. Different features of the high-energy impact ionization and certain connections between the ionization and the discrete-level excitation are discussed. (auth) (STAR)

1159 (UCID-15352) FAST THOMAS-FERMI-LIKE EQUATION OF STATE. Zink, J. W. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 15, 1968. Contract W-7405-eng-48. 14p. Dep. CFSTI.

A method of obtaining a Thomas–Fermi-like equation of state is described. The method requires a minimum of computing time and can consequently be used directly in hydro codes. (auth)

1160 ON THE POSSIBILITY OF EXPERIMENTAL OBSERVATION OF HARD VAVILOV-CHERENKOV RADIATION. Batyghin, V. V. (Kalinin Polytechnic Inst., Leningrad). Phys. Lett., 28A: 64-5(Oct. 21, 1968).

It is estimated that demands for experimental observation of recently investigated theoretically hard Vavilov–Cherenkov radiation at moderate energies are realizable. (auth)

1161 NOTE ON THE ELECTRON MEAN LOSS OF ENERGY IN ELASTIC ENCOUNTERS. Braglia, G. L. (Univ., Parma, Italy). Phys. Lett., 28A: 48-9(Oct. 21, 1968).

A formula is derived for the electron mean loss of energy per elastic collision, correct to the first order for the thermal motion of the target atoms. (auth)

1162 POLARIZED POSITRON ANNIHILATION IN FERROMAGNETIC GADOLINIUM. Hohenemser, C.; Weingart, J. M.; Berko, S. (Brandeis Univ., Waltham, Mass.). Phys. Lett., 28A: 41-2(Oct. 21, 1968).

Measurements of the angular correlation of positron annihilation radiation in ferromagnetic Gd are presented, and observed polarization effects are attributed to anisotropic spin alignment of the conduction band. (auth)

1163 POSITRON ANNIHILATION IN SMALL ATOMS. Lebeda, Charles Frank. Iowa City, Iowa, Univ. of Iowa, 1968. 100p.

Thesis.

Methods of determining wave functions for bound positron–atom complexes are discussed. It is proposed that both qualitative and quantitative explanations of these phenomena can be given if accurate calculations of wave functions can be performed. A number of calculational techniques are considered for use on the simple systems positronium hydride, PsH, and the complex of a positron and a helium atom. A variation–perturbation calculation using a cusp-satisfying zero-order wave function is tested on the helium atom and found to yield a too-slowly convergent power series. A variation–perturbation technique, which requires neither partitioning of the Hamiltonian nor resolvent techniques but uses accurate variational wave functions as the zero-order wave function, is tested on the helium atom. The resulting perturbation series is found not to converge rapidly enough to meet the stringent accuracy requirements for the two positronic calculations. An iterative calculation based on this scheme is also tested and found not to converge rapidly enough, either. From these calculations, it is concluded that perturbation techniques are inadequate where binding energies are likely to be very small. A Rayleigh–Ritz variational calculation is then carried out to determine the ground-state and first excited-state energies of PsH. Open- and closed-shell exponential functions both containing virtual positronium, multiplied by power series expansions in the interparticle distances for the problem are each used as trial functions. Various simple combinations of coordinates in the series are tried. Terms involving only powers of the interelectronic distance are found to give the largest contributions to lowering the energy. A twelve-term expansion, used in conjunction with the open-shell exponential function is found to yield a ground state-energy of –0.7742 a.u., or a binding energy of 0.657 eV for Ps to H. The mean lifetime for the positron in this state is calculated to be 2.66×10^{-10} sec. A seventeen-term expansion, in conjunction with the closed-shell exponential function, yields an energy of –0.7724 a.u. for this state. Neither form of function predicts that any of the excited states of this system are bound. The system of a helium atom and a positron is found not to be bound. It is found that, in general, inclusion of preferred dissociation products in the bound-state wave function is important for obtaining an accurate wave function for the bound system. It is pointed out that this can be done by viewing the positron as a "nucleus," and treating the system with a diatomic molecule approximation. (TSS) (Diss. Abstr.)

1164 RADIOMETRY AND PHOTOMETRY: UNITS AND CONVERSION FACTORS. Meyer-Arendt, Jurgen R. (Pacific Univ., Forest Grove, Oreg.). Appl. Opt., 7: 2081-4(Oct. 1968).

Although often colorful and of historical interest, some radiometric and photometric units are redundant and illogical. The essential units are few in number. These, together with their definitions and conversion factors, are presented. (auth)

1165 DETERMINATION OF g-FACTOR RATIOS FOR FREE ^{85}Rb AND ^{87}Rb ATOMS. White, C. W.; Hughes, W. M.; Hayne, G. S.; Robinson, H. G. (Duke Univ., Durham, N. C.). Phys. Rev., 174: 23-32(Oct. 5, 1968).

The ratio of the nuclear g factor to the electronic g factor in the ground electronic state of free ^{85,87}Rb atoms has been determined using optical pumping techniques in a magnetic field of ≤50 G. Typical linewidths were ≤15 cps. The linewidth contribution due to magnetic field effects was less than 1 cps. The ratio of electronic g factors for the Rb isotopes was also measured. The results are $-g_I/g_J(^{87}\text{Rb}) = 4.969\ 914\ 7 \times (1 \pm 0.9 \times 10^{-6}) \times$

10^{-4}, $-g_I/g_J(^{85}Rb) = 1.466\ 490\ 8 \times (1 \pm 2.1 \times 10^{-6}) \times 10^{-4}$, and $g_J(^{87}Rb)/g_J(^{85}Rb) = 1.000\ 000\ 004\ 1 \times (1 \pm 6.0 \times 10^{-9})$. These results were obtained from evacuated wall-coated cells having the Lorentzian line shape. Cells filled with inert buffer gases exhibited small, uncontrollable, systematic error due to non-Lorentzian line shape. In both types of cells, the Zeeman resonances exhibited frequency shifts proportional to the pumping-light intensity. The ratio $g_I(^{85}Rb)/g_I(^{87}Rb) = 0.295\ 073\ 6 \times (1 \pm 2.3 \times 10^{-6})$ was obtained by combining the results above. The combination with results of other researchers yields the chemical shift of Rb^+ in aqueous solution relative to the free atom as $\Delta\sigma(Rb^+_{aq}/Rb) = -(211.6 \pm 1.2) \times 10^{-6}$. Absolute values in units of the Bohr magneton for the shielded nuclear moments are derived using only g-factor ratios for free atoms: $g_I(^{87}Rb) = -0.955\ 141\ 4 \times 10^{-3} \times (1 \pm 1.0 \times 10^{-6})$ and $g_I(^{85}Rb) = -0.293\ 6400 \times 10^{-3} \times (1 \pm 2.2 \times 10^{-6})$. (auth)

1166 EXPERIMENTAL AND THEORETICAL STUDY OF THE MOMENTUM DISTRIBUTION OF TWO-PHOTON ANNIHILATING POSITRON–ELECTRON PAIRS IN METHANE. Chuang, S. Y.; Holt, W. H.; Hogg, B. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys., 46: 2309-14(Oct. 15, 1968).

The momentum distributions of annihilating positron–electron pairs were measured in liquid and solid methane. Calculated momentum distributions generally assume that the positron wave function $\psi_+ = 1$. This low-momentum, plane-wave representation of the positron is inadequate to describe the experimental distribution for high momenta. A ψ_+ obtained by numerical integration of the groundstate radial Schrödinger equation is employed in the calculation and a good fit is observed with experiment for all momentum values. (auth)

1167 MONOCHROMATISATION OF ELECTRON BEAMS AND IMPROVEMENT OF EMISSION IMAGES BY MEANS OF AN ELECTRON MIRROR. Moellenstedt, G.; Gruner, H. (Univ., Tuebingen, Ger.). Optik, 27: 602-4(Sept. 1968). (In German).

In an arrangement similar to the one used by R. Castaing, an electron beam is first deflected by a magnetic field, and then running against the retarding electrostatic field of an electron mirror. The mirror potential is chosen so that the fast part of the electron energy distribution is landing on the mirror surface while the slow electrons are reflected. The half width of the energy distribution of the reflected beam can be made much narrower than that of the incoming beam. This filtering effect is used to reduce the energy half width of the electrons from heated filaments and from ion-bombarded surfaces. In an electrostatic energy analyzer the monochromatizing effect is demonstrated. It is shown that contrast and resolution of electron emission micrographs can be improved. (auth)

1168 ELECTRON DRIFT AND DIFFUSION IN PARAHYDROGEN AT 77°K. Crompton, R. W.; McIntosh, A. I. (Australian National Univ., Canberra). Aust. J. Phys., 21: 637-47(Oct. 1968).

A series of experiments to measure electron diffusion and drift in pure parahydrogen at 77°K is reported. Tables of data are given for the electron drift velocity W in the range $1.2 \times 10^{-19} \leq E/N \leq 9.5 \times 10^{-17}$ V cm^2 and for the ratio of diffusion coefficient to mobility D/μ for $2 \times 10^{-20} \leq E/N \leq 6 \times 10^{-17}$ V cm^2. As expected, these data are indistinguishable from the data for normal hydrogen in the thermal region and at the higher values of E/N where vibrational excitation is the dominant process controlling the electron energy distribution. However, at intermediate values of E/N, the values of W and D/μ differ by more than 10 and 20%, respectively, from the corresponding values in normal hydrogen, demonstrating the influence of the difference in the statistical weights of the rotational levels in the two gases. (auth)

1169 PHOTOELECTRON SPECTROSCOPY. Turner, D. W. (Oxford Univ.). Chem. Brit., 4: 435-40(Oct. 1968).

The measurement of electron kinetic energy distributions following photoionization (photoelectron spectroscopy) has been used to determine the inner electronic structure of atoms and molecules. It has applications in theoretical and structural chemistry, chemical physics of the upper atmosphere, and analysis. (auth) (UK)

1170 DEDUCTION OF INTERATOMIC POTENTIALS IN AMORPHOUS SOLIDS FROM LOW-ENERGY ION RANGE MEASUREMENTS. Carter, G.; Grant, W. A.; Whitton, J. L. (Univ. of Salford, Eng.). Phil. Mag., 18: 873-5(Oct. 1968).

It is shown that from studies of ion ranges and range moments in amorphous solids a form for the interatomic potential between the incident ion and the atoms of the solid can be deduced. The treatment is based upon a very good approximate treatment of the scattering of an ion by an atom, using a perturbed momentum approximation. (auth) (UK)

1171 ELECTRON AFFINITIES OF ATOMS. Politzer, Peter (Louisiana State Univ., New Orleans). Trans. Faraday Soc., 64: 2241-6(Sept. 1968).

Evidence is presented to show that there exists a relationship, for most of the nontransition elements, between the quantity (IP – EA), the difference between the ionization potential and the electron affinity of an atom or ion, and the average radius of the highest-energy electron. The equation $(IP - EA) = k(1/\langle r \rangle)^n$, where k and n are parameters that are constant within each vertical family of the periodic table, is closely obeyed in all cases where it could be tested. It should therefore be possible to use an equation of the same type to calculate the electron affinities of many atoms for which the values are not known, provided that there are two electron affinities known in each vertical group, so that the values of the parameters k and n can be established. In this manner, electron affinities were calculated for many of the nontransition elements for which no values were previously available. (auth) (UK)

1172 THEORY OF POLARIZED ELECTRON-BEAM PRODUCTION BY FIELD EMISSION FROM FERROMAGNETS. Obermair, Gustav (Univ. of Oregon, Eugene). Z. Phys., 217: 91-112 (1968).

A theory is given for field emission from ferromagnetic solids in which the two spin subbands of the conduction band are split by exchange forces. A simple plane-wave model for the conduction band states is used to show that the familiar WKB approximation for the tunneling probability has to be improved by momentum-dependent factors to account for the spin polarization of the emission current observed in a recent experiment, which is 8% in the case of Gd. The calculations are extended to describe emission from Bloch states. Applications of the theory to various ferromagnetic systems are discussed; the use of ferromagnetic $Eu_{1-x}Gd_xS$ as a source for highly polarized beams is suggested. (auth)

1173 SHELL MODEL ANALYSIS OF THE MAGNETIC HYPERFINE SPLITTING IN MUONIC THALLIUM. Engfer, R. (Institut fuer Technische Kernphysik, Darmstadt, Ger.); Scheck, F. Z. Phys., 216: 274-80(1968).

The magnetic hyperfine splitting of the ground and first excited state in muonic ^{203}Tl and ^{205}Tl is calculated on the basis of the shell model with configuration mixing. Fair agreement with the recently measured ground state splitting is found. (auth)

1174 ENERGY AND WIDTH MEASUREMENTS OF THE PIONIC 2p–1s TRANSITION IN ^{23}Na. Miller, G. H.; Eckhause, M.; Sapp, W. W.; Welsh, R. E. (Coll. of William and Mary, Williamsburg, Va.). Phys. Lett., 27B: 663-4(Oct. 14, 1968).

New measurements of the energy and natural linewidth of the pionic 2p–1s x-ray transition and of the energy of the muonic 2p–1s x-ray transition in ^{23}Na have been performed. A high-resolution Ge(Li) spectrometer was used, resulting in more precise measurements than previously reported. Comparisons are made with the theoretical predictions of the Ericsons. (auth)

1175 ELECTRON-IMPACT IONIZATION CROSS SECTIONS AND IONIZATION RATE COEFFICIENTS FOR ATOMS AND IONS FROM HYDROGEN TO CALCIUM. Lotz, Wolfgang (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 216: 241-7(1968).

The empirical formula recently proposed was used to calculate electron-impact ionization cross sections for single ionization from the ground state for free atoms and for all ionization stages from hydrogen to calcium (Z = 20). Ionization rate coefficients are given for these species on the assumption of a Maxwellian distribution of the impacting electrons. Multiple ionization, lowering of ionization potential, or collision limit are not taken into account. (auth)

1176 MULTIPHOTON IONIZATION OF ATOMIC HYDROGEN. Zernik, Wolfgang (RCA Labs., Princeton, N. J.). Phys. Rev., 176: 420-1(Dec. 5, 1968).

A recent publication by Gontier and Trahin is commented on. A comparison of the author's previously unpublished calculation with their result for the two-photon ionization of atomic hydrogen in the ground state shows significant numerical discrepancies. (auth)

1177 ELECTRON EJECTION FROM SOLIDS BY ATOMIC PARTICLES WITH KINETIC ENERGY. Krebs, Karl Heinz (Humboldt-Univ., Berlin). Fortschr. Phys., 16: 419-90(1968).

Experimental and theoretical investigations of electron emission from solids bombarded by energetic atoms and ions are reviewed. Experimental arrangements and methods are described and compared. It is concluded that the best results were obtained by methods that used a mass spectrometer for production of a defined beam of bombarding particles, attained ultrahigh vacuum in the target chamber, and used special care for the preparation of a

clean surface. Results are collected and compared, and areas in which more data are needed are pointed out. Theories currently considered compatible with experimental data are discussed. (237 references) (A.G.W.)

1178 SHELL STRUCTURE AND THE THOMAS–FERMI EQUATION OF STATE. Zink, J. W. (Univ. of California, Livermore). Phys. Rev., 176: 279-84(Dec. 5, 1968).

The calculation of the electronic contribution to the equation of state of high-temperature, high-density matter by means of Thomas–Fermi theory is modified to include the effect of shell structure. Shell structure is included by accounting for the discrete nature of the energy levels of the bound states. The free states are treated by means of Thomas–Fermi theory. Comparisons are made between Thomas–Fermi (TF) theory and Thomas–Fermi shell (TFS) theory. The pressure and energy calculated by means of TFS theory vary about those calculated by means of TF theory, and for some temperatures and densities they are substantially different even at pressures far in excess of the 100-Mbar region where TF theory is generally thought to be applicable. (auth)

1179 RELATIVISTIC CALCULATIONS OF ELECTRON BINDING ENERGIES BY A MODIFIED HARTREE–FOCK–SLATER METHOD. Rosen, Arne; Lindgren, Ingvar (Chalmers Univ. of Tech., Goteborg). Phys. Rev., 176: 114-25(Dec. 5, 1968).

Relativistic atomic wave functions and electron binding energies have been calculated by a modified Hartree–Fock–Slater method. The local exchange approximation, originally introduced by Slater, is modified in such a way that the total energy of the system is minimized. Approximate expressions for the optimum exchange potential are suggested for all atoms and ions. The total atomic energies and electron binding energies obtained by this method agree extremely well with the corresponding Hartree–Fock results in the cases where such data are available. Various corrections to the theoretical binding energies are discussed, in particular the effect of rearrangement during the ionization process. It is found that this effect is of importance for inner shells in all elements and is responsible for the main discrepancy between experimental and previous theoretical results for light and medium-heavy elements. For heavy elements other effects are of importance, and various possible sources of the residual discrepancy between theory and experiments are discussed. (auth)

1180 QUANTUM MECHANICAL STUDY OF THE $F^1\pi_u$ AND $f^3\pi_u$ STATES OF He_2. Gupta, Balkrishna. Austin, Tex., Univ. of Texas, 1968. 128p.

Thesis.

A quantum mechanical study of the two states, $F^1\pi_u$ and $f^3\pi_u$, of the helium molecule is made using the valence bond method with configuration interaction. The variation principle is employed to ensure that the energy calculated is a rigorous upper bound to the true energy. Final calculations with 49-term wave functions suggest the existence of more vibrational levels than have hitherto been observed for both states. The spectroscopic constants agree extremely well with the experimental values. The existence of maxima in the potential-energy curves of the states under study is discussed in terms of the noncrossing rule and the molecular state correlation diagrams. A semiempirical pseudokinetic energy correction is applied to the potential-energy curves. (Disser. Abstr.)

1181 HYPERFINE ENERGY SPLITTING OF POSITRONIUM MEASURED IN WATER. Iaci, G.; Lo Savio, M.; Turrisi, E. (Univ., Catania, Italy. CNR, Catania, Italy). Can. J. Phys., 46: 2033-8(Sept. 15, 1968).

In order to investigate the behavior of positronium in water, magnetic quenching measurements were performed at various temperatures from 0 to 45°C and with applied fields up to 12.5 kG. From these measurements it was possible to evaluate the effect of the water. In fact, while for the positronium free atom in the ground state the hyperfine structure energy splitting is $\Delta W_0 = 8.34 \times 10^{-4}$ eV, for positronium in water two consistent values, $\Delta W = (6.32 \pm 0.20) \times 10^{-4}$ eV and $\Delta W = (7.30 \pm 0.80) \times 10^{-4}$ eV were obtained by considering the magnetic-field effect on the positronium component that decays by pickoff and on its decay rate. (auth) (Canada)

1182 MEASUREMENTS OF PIONIC AND MUONIC K_α X-RAY ENERGIES IN LOW Z ATOMS. Shuler, William Beeuwkes. Williamsburg, Va., Coll. of William and Mary, 1968. 117p.

Thesis.

Pionic and muonic K_α x-ray energies have been measured for elements in the range Z = 3 to Z = 6 by high-resolution Si(Li) and Ge(Li) γ-ray spectrometers. Level corrections due to vacuum polarization and the finite extent of the nuclear-charge distribution have been calculated. The nuclear-force shifts due to the strong pion–nucleus interaction have been measured for the 1s levels of pionic atoms and are found to be in fair agreement with the shifts calculated according to the theory of the Ericsons. The x-ray energy and nuclear-force-shift measurements reported represent a substantial improvement in precision over previous measurements. The measured pionic and muonic K_α x-ray energies and the pionic 1s level nuclear force shifts (keV) are tabulated. Nuclear radii determined from the muonic x-ray data were found to be in agreement with those determined from electron-scattering experiments. (Disser. Abstr.)

1183 THEORY OF ELECTRONIC TRANSITIONS IN SLOW ATOMIC COLLISIONS. Heinrichs, Jean (Univ. of California, San Diego, La Jolla). Phys. Rev., 176: 141-9(Dec. 5, 1968).

The near-adiabatic transition probability between a pair of pseudo-crossing adiabatic (molecular) electronic states is studied by generalizing Zener's time-dependent treatment and describing the heavy-particle motion classically. This more rigorous formalism, based however on the simple Landau–Zener model, leads to the well-known Landau–Zener formula in a first approximation. From a reasonable definition of the width of the finite region over which the transitions take place on the trajectory, a precise condition which inherently limits the validity of the formula is derived. This condition may be compared with similar ones obtained in recent quite different derivations and removes some apparent difficulties which have been raised in connection with earlier treatments. The first correction to the Landau–Zener formula, associated with the finiteness of the transition region, is studied analytically and found to be important and to have interesting properties. This leads to further information about the validity of the simple Landau–Zener expression. (auth)

1184 ELECTRON-IMPACT IONIZATION OF H(2s) AND H(2p). Kyle, H. Lee; Omidvar, K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., 176: 164-72(Dec. 5, 1968).

Cross sections for the electron-impact ionization of the 2s and the 2p, m = 0, ±1 states of atomic hydrogen have been calculated, using two forms, B.E. (i) and B.E. (ii), of the Born-exchange approximation. For the form B.E. (i), it is found that inclusion of exchange increases the cross section for the 2p (m = ±1) → c transition, but decreases the cross sections for the 2s → c and 2p (m = 0) → c transitions. In the B.E. (ii) calculation, inclusion of exchange always decreases the cross sections. For the 2s → c transition Prasad's Born-exchange calculations are verified. The binary collision approximation of Vainshtein was applied to the 2s and the 2p ionization, and it is found that the Vainshtein approximation with its proper choice of effective charge does not agree with the Born-exchange approximation. A new expression for the exchange amplitude has been derived in the Vainshtein approximation. The results of the Born, the Born-exchange, the Born–Ochkur, and the Vainshtein's approximations for the ionization of the 1s, 2s, and the 2p states of atomic hydrogen are compared. (auth)

1185 SPIN POLARIZATION OF LOW-ENERGY ELECTRONS SCATTERED ELASTICALLY FROM ATOMS AND MOLECULES. Yates, A. C. (Indiana Univ., Bloomington). Phys. Rev., 176: 173-80(Dec. 5, 1968).

The Z dependence of total spin polarization is systematically ascertained by tracing the trajectory of a particular zero of the scattered amplitude as a function of atomic number. The incident electron energy corresponding to 100% polarization is shown to increase linearly with increasing atomic number. In addition, it is found that total polarization is confined to a relatively narrow angular range for varying Z. Further calculations on the independent-atom model representation of electron spin polarization for electron–molecule collisions are given. Arguments leading to the improbability of obtaining enhanced polarization over the atomic case are presented. The most significant result of these calculations is the relative insensitivity of the spin polarization to the molecular parameters. (auth)

1186 ROTATIONAL EXCITATION OF POLAR MOLECULES BY ELECTRONS. Mittleman, M. H. (Univ. of California, Berkeley); Peacher, J. L.; Rozsnyai, B. F. Phys. Rev., 176: 180-6 (Dec. 5, 1968).

Rotational excitation of polar molecules is calculated in the approximation that the electron transit time is short compared with rotational periods with the result of an E^{-1} behavior of the cross section. Diffusion cross sections are calculated for $\Delta l = 0$, 1, and 2. Significant corrections to the Born approximation are obtained for large dipole moments. The range (in energy) of applicability of the result is discussed in terms of the energy dependence of the corrections, and a novel energy dependence of these corrections is encountered and explained. (auth)

1187 THEORY OF POLARIZATION OF MOLECULAR LINE RADIATION EXCITED BY ELECTRON IMPACT. Jette, A. Norman (Johns Hopkins Univ., Silver Spring, Md.); Cahill, Patrick. Phys. Rev., 176: 186-93(Dec. 5, 1968).

The Percival–Seaton theory for the polarization of atomic impact radiation is extended to the case of diatomic molecules. Similar to the atomic case, it is shown that for excitation by electron impact involving a change of electronic angular momentum along the molecular internuclear axis, the threshold polarization can be determined from the symmetry of the total molecular wave function without a detailed knowledge of the inelastic cross sections. General expressions are developed for the cases of fine and hyperfine splitting, and explicit relations are given for the first two rotational levels of a $^3\Pi_u$ state undergoing a radiative transition to a $^3\Sigma_g$ state in the limit of fine and hyperfine separations being much larger than the natural linewidth. This theory is valid when the radiative state is populated by a direct interaction, and the radiative transition between rotational states is resolved. (auth)

1188 ANGULAR DEPENDENCE OF SCATTERING PRODUCTS IN ELECTRON–MOLECULE RESONANT EXCITATION AND IN DISSOCIATIVE ATTACHMENT. O'Malley, Thomas F. (General Research Corp., Santa Barbara, Calif.); Taylor, Howard S. Phys. Rev., 176: 207-21(Dec. 5, 1968).

For the processes mentioned in the title, the general rearrangement formalism of a previous paper is applied with specific consideration to the effect of molecule orientation on the electronic matrix elements and on the total and differential cross sections. Formulas are given for two cases: when one can and when one cannot treat the effect of rotation as a semiclassical orientation average. A short discussion is given of selection rules and of the use of these formulas in (a) ab initio calculation of the cross section, (b) approximate prediction of angular dependence, and (c) parametrization of experimental data. (auth)

1189 MEASUREMENTS OF THE ELECTRON IMPACT EXCITATION CROSS SECTION OF N_2^+ FIRST NEGATIVE BANDS. Srivastava, B. N.; Mirza, I. M. (Univ. of Alaska, College). Phys. Rev., 176: 137-40(Dec. 5, 1968).

Emission cross sections for the N_2^+ first negative bands produced by electron impact on N_2 have been measured using a photon counting technique in the energy range 70 eV to 4 keV. The maximum cross section for the $v' = 0$ vibrational level of the $B^2\Sigma_u^+$ excited state of N_2^+ is 2.38×10^{-17} cm^2. The ratio of cross sections for the (0,0) (0,1), and (0,2) bands of the first negative system is 1 : 0.34 : 0.065. The total emission cross section for the $v' = 0$ vibrational level accounts for 10% of the total ionization cross section of N_2. (auth)

1190 ANGULAR DISTRIBUTION OF MOLECULAR PHOTOELECTRONS. Tully, John C.; Berry, R. Stephen; Dalton, Bryan J. (Univ. of Chicago). Phys. Rev., 176: 95-105(Dec. 5, 1968).

The nonrelativistic differential cross sections for photoionization of molecules are derived and are worked out in detail for systems with random orientation. The more important contributions due to electric dipole, electric quadrupole, magnetic dipole, and two-photon (nonresonant) absorption have been included. Processes such as vibrationally induced auto-ionization have been discussed. The significance of these results with regard to the design and interpretation of photo-ionization experiments is also considered. The angular distribution of photoelectrons from H_2 is calculated as an example. (auth)

1191 TEMPERATURE DEPENDENCE OF SEVERAL REACTION RATES OF THE HELIUM METASTABLE ATOMS. Jones, Claude Randol. Austin, Tex., Univ. of Texas, 1968. 133p.

The temperature dependence of several reactions of both helium metastable atoms has been experimentally determined. The reactions were observed in the afterglow of a pulsed helium discharge at several cell temperatures. Time-varying optical absorption was used to monitor the exponential decay of the metastable atoms after the discharge pulse. The temperature dependence of the conversion of the metastable atoms to molecular complexes provides an experimental check for recent quantum mechanical calculations: The tertiary conversion of $He(2^3S_1)$ to $He_2(a^3\Sigma_u^+)$ exhibited an activation energy of 0.055 eV. Similarly, the destruction of $He(2^1S_0)$ by collision-induced radiation suggested a potential maximum in the $He_2(A^1\Sigma_u^+)$ state of 0.04 eV. The variation with temperature of the rate of excitation transfer from the helium metastable atoms to neon is particularly important in gaseous laser research. The triplet metastable transfer to the Ne(2s) states showed an activation energy for the reaction of 0.044 eV. Similar results were obtained for the cross section for excitation transfer from the singlet to the Ne(3s) states; an activation energy for the process of 0.034 eV was indicated. The temperature dependence of the rate for destruction of $He(2^3S_1)$ by argon was also measured; the cross section decreased slowly with temperature over the 193 to 500°K temperature range. Mechanisms and models for this important class of ionizing reactions are discussed considering this and other experimental evidence. (Disser. Abstr.)

1192 AUTOIONIZING LEVELS OF NEON PRODUCED BY H^+, He^+, AND Ne^+ BEAMS. Edwards, Alan Kent. Lincoln, Neb., Univ. of Nebraska, 1968. 82p.

The autoionizing levels of neon were produced by bombarding neon with H^+, He^+, and Ne^+ beams in the energy range 100 to 300 keV. The electrons ejected by neon were observed at 160° from the beam direction. A parallel-plate analyzer was used to energy analyze the electrons before allowing them to strike the first dynode of a 14-dynode electron multiplier. An X–Y recorder was used to make a plot of relative count rate versus electron energy. The count rate was divided by the beam current to eliminate any effects due to a changing beam intensity. The most intense transitions observed were due to inner shell excitations of Ne I and Ne II. Some two-electron excitations were also observed. The He^+ beam was found to produce strong triplet S and triplet P series of inner-shell-excited Ne I. Of a total of 60 peaks found, 43 were identified. The others are expected to be first members of series formed by two-electron excitation of Ne I and Ne II. Auger transitions of neon were also produced by a 300-keV H^+ beam. These transitions agreed well with the values of Korber and Mehlhorn. Neon lines, Doppler shifted in energy, were observed at 10°. These were produced by Ne^+ on H_2 collisions. (Disser. Abstr.)

1193 FORBIDDEN VIBRATIONAL TRANSITIONS IN THE ELECTRON-IMPACT SPECTRA OF MOLECULAR OXYGEN AND NITROGEN. Skerbele, Ausma; Dillon, Michael A.; Lassettre, Edwin N. (Carnegie-Mellon Univ., Pittsburgh). J. Chem. Phys., 49: 3543-5(Oct. 15, 1968).

The excitation of forbidden vibrational transitions by electron impact has been studied at 45-eV electron kinetic energy. The relative intensities of these transitions in N_2 and O_2, referred to the elastic peak, are independent of the scattering angle between 3° and 14°. For comparison data are also included on vibrational transitions in CO and NO at one angle (4°). These are allowed by electric-dipole selection rules. In molecular oxygen the forbidden electronic transitions a $^1\Delta_g \leftarrow X^3\Sigma_g^-$ and $b^1\Sigma_g^+ \leftarrow X^3\Sigma_g^-$ were also observed, although the latter can be barely detected above background. (auth)

1194 CLASSICAL PROBABILITIES OF REACTION AND TRANSMISSION COEFFICIENTS FOR ISOTOPIC REACTIONS OF THE TYPE $H + H_2 = H_2 + H$. Mortensen, Earl M. (Univ. of Massachusetts, Amherst). J. Chem. Phys., 49: 3526-31(Oct. 15, 1968).

Classical trajectories for the linear collision of an H atom and an H_2 molecule and their isotopic substitutions have been calculated as a function of energy with the molecule having the zero-point vibrational energy. Probabilities of reaction are calculated by averaging over the vibrational phases during collision. These results are compared with recently reported quantum-mechanical calculations for the same systems. (auth)

1195 EFFECT OF AN EXTERNAL RADIATION ON THE ENERGY LEVELS OF AN ELECTRON SYSTEM. Jones, B. L.; Verschueren, M. (Simon Fraser Univ., Burnaby, Can.). Phys. Rev., 176: 42-8(Dec. 5, 1968).

The effect of an external radiation on the energy levels of an electron system is treated by a Green's-function technique. The external radiation is treated classically and is assumed to be totally incoherent. Using the statistical properties of the external radiation, an averaged one-electron Green's function which describes the properties of the electron system is defined and evaluated. The formalism includes the vacuum radiation corrections to the electron system. Expressions for the energy shifts and linewidths induced by the external radiation are obtained. (auth)

1196 AB INITIO CALCULATION OF SCREENING EFFECTS ON $|\psi(0)|^2$ FOR HEAVY ATOMS. Wilson, M. (Johns Hopkins Univ., Baltimore). Phys. Rev., 176: 58-63(Dec. 5, 1968).

Hartree–Fock calculations are used to investigate screening effects on the values of $|\psi(0)|^2$ for heavy atoms. It is shown that such calculations represent reasonably well the actual screening behavior derived from observed isotope (and isomer) shifts. In addition to the already known importance of 5p and 5d electron screening effects, it is found, in the case of the actinides, that 5f screening effects are also important. (auth)

1197 ON PAIR CORRELATION IN THE THEORY OF ATOMIC STRUCTURE. Condon, E. U. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Rev. Mod. Phys., 40: 872-5(Oct. 1968).

Approaches used by various workers in dealing with electron correlation in atoms are summarized. Relationships between the various approaches are discussed with the intent of clarifying possible confusion in the literature. (A.G.W.)

1198 HIGH-ORDER PERTURBATION THEORY FOR A ONE-ELECTRON ION IN A UNIFORM ELECTRIC FIELD. Mendelsohn, Lawrence B. (Polytechnic Inst. of Brooklyn, N. Y.). Phys. Rev., 176: 90-5(Dec. 5, 1968).

Large-Z expansion theory is applied to the nonrelativistic ground state of a one-electron ion and the subsequent first-order differential equations are solved recursively. For each order of perturbation theory, a general expression for the wave function is found. The substitution of this form into the perturbation-theory equations reduces the problem for the Kth-order wave function and energy to solving recursively a set of linear algebraic equations of approximately 2Kth order for the coefficients of certain radial polynomial terms appearing in the wave function. The asymptotic-series results for both the energy and the wave function are obtained explicitly through tenth order. For hydrogen a calculation of the ionization field (ignoring tunneling) gives a value of 3.36×10^8 V/cm. This agrees well with experimental results on field ionization and a recent accurate variational treatment and is found to be much superior to a WKB result. (auth)

1199 MATHEMATISCHE GRUNDLAGEN DER QUANTENMECHANIK. (Mathematical Principles of Quantum Mechanics). Neumann, Johann v. Die Grundlehren der Mathematischen Wissenschaften in Einzeldarstellungen mit Besonderer Berucksichtigung der Anwendungsgebiete. Band 38. Berlin, Springer-Verlag, 1968. 270p. DM 28.-; $7.00.

The transformation theory is presented in a uniform mathematically acceptable representation. The guiding principles in the formulation of the transformation theory are outlined. Generalities are given on the abstract Hilbert space, and quantum mechanical statistics are presented. The deductive construction of the theory is obtained. The formulation and processing of the measurement process is illustrated. (J.S.R.)

1200 CHARGE TRANSFER AND ION-ATOM INTERCHANGE REACTIONS OF WATER VAPOR IONS. Turner, B. R.; Rutherford, J. A. (Gulf General Atomic Inc., San Diego, Calif.). J. Geophys. Res., 73: 6751-8(Nov. 1, 1968).

Charge-transfer cross sections resulting in either the production or the loss of H_2O^+ were studied in the energy range 1 to 400 ev by using the crossed ion and neutral beam technique and employing mass analysis of the primary and product ions. The ions incident on H_2O neutral beams were N^+, O^+, N_2^+, NO^+, O_2^+, and Ar^+; the H_2O^+ ion beams were incident on neutral beams of O_2, NO, and H_2O. The effects of the excited ions in the incident beam upon the cross sections were also investigated. The cross section for a rearrangement collision, $H_2O^+ + H_2O \rightarrow H_3O^+ + OH$, was also measured. The implications of these results to atmospheric models are discussed. (auth)

1201 CALCULATION OF FRANCK-CONDON FACTORS WITH POSCHL-TELLER WAVEFUNCTIONS. I. THE PROBABILITIES OF SOME VIBRATIONAL TRANSITIONS IN THE $D^1\Sigma_\mu^+ - B^1\Pi_g$ BAND SYSTEM OF THE He_2 MOLECULE. Zhirnov, N. I.; Shadrin, O. P. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 478-80(June 1968).

Translated from Opt. Spektrosk., 24: 890-5(June 1968).

Solutions of the wave equation based on the Poschl-Teller potential were obtained for the discrete and continuous spectrum and are convenient for further applications. The wave functions obtained were used to calculate the Franck-Condon factors for several vibrational transitions in the $D^1\Sigma_\mu^+ - B^1\Pi_g$ band system of the He_2 molecule according to a method analogous to the method of average Morse potential. (auth)

1202 FERMI ENERGY AND DOPPLER-BROADENED ANNIHILATION RADIATION. van den Berg, H.; Ramaswami, M. K. (Fordham Univ., Bronx, N. Y.). Nuovo Cim., 57B: 521-2(Oct. 11, 1968).

Doppler broadening was investigated in the following materials: Cu, Al, Pb, Fe, Ni, Sb, Gd, Bi and Zn. The apparatus consisted of a Ge(Li) detector (5 cm^2 area; 4 mm depth) which has a resolution of 2.7 keV for the 514-keV line of ^{85}Sr used for obtaining the instrumental linewidth. The output of the FET preamplifier coupled to the detector was fed to a Canberra spectroscopy amplifier (Model 1417) and then to a biased amplifier (Canberra Model 860). The output of this was analyzed by a Victoreen 400-channel analyzer. The positron source consisting of a 10-μC ^{22}Na activity deposited at the center of a ½-cm-diameter Mylar foil (¼-mil thick) was sandwiched between two pieces of a given specimen and placed 4 cm from the front face of the detector. The counting time for each sample was approximately 20 minutes and data for all samples were taken on the same day. (M.O.W.)

1203 VARIATIONAL SOLUTIONS OF THE THOMAS–FERMI EQUATION. Anderson, N.; Arthurs, A. M.; Robinson, P. D. (Univ. of York, Eng.). Nuovo Cim., 57B: 523-6(Oct. 11, 1968).

Recently there has been renewed interest in approximate analytical solutions of the equation $(d^2\varphi/dx^2) = (\varphi^3/x^{3/2})$, $0 \leq x < \infty$, subject to the boundary conditions $\varphi(0) = 1$; $\varphi \rightarrow 0$, $x\varphi' \rightarrow 0$ as $x \rightarrow \infty$. This determines the Thomas–Fermi screening function $\varphi(x)$ for neutral atoms with spherical symmetry. Csavinsky has proposed the trial function $\Phi_1 = (ae^{-\alpha x} + be^{-\beta x})^2$, $a + b = 1$, while Roberts suggests $\Phi_2 = (1 + \gamma x^{1/2}) \exp[-\gamma x^{1/2}]$. These approximate solutions were investigated further in the light of complementary variational principles which have been developed for the Thomas–Fermi equation. Contrary to the assertion of Csavinsky, it transpires that single-parameter functions can be quite accurate. (M.O.W.)

1204 SPECTRAL LINE PROFILE FORMED BY THE COMBINED EFFECT OF RESONANCE BROADENING AND REABSORPTION. Preobrazhenskii, N. G.; Galaktionova, S. B. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 472-4(June 1968).

Translated from Opt. Spektrosk., 24: 879-83(June 1968).

The variation of the principal characteristics of a reabsorbed line profile is studied as a function of the integrated optical thickness for the case in which the initial half-width of the line contains the contribution of a component due to self-pressure. The calculated results are applied to certain recent experiments with a dense plasma, and the validity of a linear relation between the resonance half-width and the concentration of atoms is discussed. (auth)

1205 LOW-ENERGY ARGON SPUTTERING OF SINGLE-CRYSTAL SEMICONDUCTING COMPOUNDS. Comas, James. Newark, Del., Univ. of Delaware, 1967. 88p.

Thesis.

An experimental study of low-energy argon sputtering has been performed on several single-crystal semiconducting compounds. Three experimental phases of the sputtering process were investigated: (1) sputtering yields, (2) mass spectrometric analysis of the sputtered particles, and (3) the angular distribution of the species sputtered. Sputtering yields from single crystals of CdS (1010), InSb (orientation unknown), SiC (0001), GaAs (110), and (111), PbTe (111), and GaP (111), under bombardment by ions with energies in the 100- to 600-eV range, were obtained using target-weight-loss techniques. A mass spectrometric analysis of the particles sputtered from the (111), $(\bar{1}1\bar{1})$, and (110) faces of GaAs by argon ions in the 40- to 140-eV range shows that the majority of the ejected particles are neutral and atomic. The results indicate that less than 1% are molecular and that the target surface is stoichiometrically sputtered. Results of the mass spectral analysis from the (111) and $(\bar{1}\bar{1}\bar{1})$ faces of GaAs indicate that the crystallographic polarity along the [111] direction does not affect the nature of the ejected species. The angular distribution of the sputtered material, however, is influenced by the polar character of the {111} surfaces. The ejection pattern is found to be dependent on the crystallographic polarity and orientation, as well as the target temperature. It does not seem likely that a rebound or surface-collision interaction can explain the observed preferential emission from the zinc-blende structure. Data obtained from the mass spectrometric studies and the sputtered distribution investigations indicate that focusing is of fundamental importance in the ejection mechanism. (TSS) (Disser. Abstr.)

1206 PRODUCTION OF ENERGETIC ATOMS BY MULTIPLE COLLISIONS. Wotzak, G. P.; Kostin, M. D. (Princeton Univ., N. J.). Radiochim. Acta, 9: 85-90(Aug. 1968).

The production of energetic atoms in the epithermal energy region by a high-energy atomic beam is considered by using the Boltzmann equation. Solutions of the Boltzmann equation show that numerous epithermal atoms may be generated as a result of scattering collisions in which an energetic atom transfers kinetic energy to a struck atom. For a system in which all the reactive and nonreactive cross sections have the same energy dependence and in which the thermal motion of the struck atoms can be neglected, numerical results obtained from a stochastic computer program confirm the analytical results for the asymptotic region and give detailed information on the energy dependence of the collision density for the nonasymptotic region near the source. Numerical calculations of reaction yields for a gaseous system containing two atomic species are also presented. (auth)

1207 Z_1 OSCILLATIONS IN STOPPING OF ATOMIC PARTICLES. Winterbon, K. B. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 46: 2429-34(Nov. 1, 1968). (AECL-2742).

The measured stopping cross sections for atomic projectiles in various materials show Z_1 oscillations, a more or less periodic dependence of the stopping on Z_1, the atomic number of the projectile. These oscillations have a larger amplitude when the projectiles are channeled in single crystals than when they are not. It is

shown that the oscillations are a size effect, i.e., the larger an atom the more it is ionized and the greater is the stopping. Calculation of stopping of low-Z ($Z_1 \leq 29$) channeled particles in tungsten and silicon give qualitative agreement with experiment: the maxima and minima are in the right places, and vary in the right way, but the calculated amplitude of oscillation is too small. Possible explanations for the amplitude discrepancy are suggested. (Canada) (auth)

1208 INCOHERENT SCATTERING OF 662-keV PHOTONS BY K ELECTRONS OF GOLD. Pingot, O. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). Nucl. Phys., A119: 667-72(1968). (In French).

The differential cross section $d\sigma_K/d\Omega$ for the incoherent scattering of 662 keV gamma rays by the K-shell electrons of gold was determined experimentally. This cross section is compared with the Klein–Nishina cross section $d\sigma_I/d\Omega$ for scattering angles from 20 to 160°. The experimental results are in good agreement with the incoherent-scattering function calculated on the basis of certain approximations. (auth)

1209 RANGE AND dE/dx of C, N, O, F, AND Ne IN Be AND C FROM 500 keV TO 2 MeV. Chu, W. K.; Bourland, P. D.; Wang, K. H.; Powers, D. (Baylor Univ., Waco, Tex.). Phys. Rev., 175: 342-53(Nov. 10, 1968).

Ranges of C, N, O, F, and Ne in Be and of O and Ne in C have been measured with an accuracy of 3.4 to 9.2% in energy intervals of 100 to 150 keV in the energy region from 500 keV to 2 MeV. Additional measurements from 200 to 500 keV have been made for C and O in Be and for O in C. The results are compared with the Lindhard–Scharff–Schiøtt theory and with a range obtained by numerically integrating a $(dE/dx)_{total}$ obtained by adding Firsov's prediction of dE/dx due to electronic excitation to the LSS prediction of dE/dx for elastic nuclear scattering. The experimental ranges at the low-energy end agree within experimental accuracy to the LSS theory for F and Ne in Be and for Ne in C, but the C-in-Be measurements disagree by as much as 29%. At the high-energy end, the disagreement varies from 11% for Ne in C to 24% for O and N in Be. The experimental values are always lower than the theoretical values; but the LSS theory does give the correct relative magnitudes of the ranges, though only qualitatively. In comparison with the Firsov predictions, the over-all disagreement is no worse than 13% for C and N in Be and for O in C, but is as high as 30–37% for F and Ne in Be. The corresponding stopping powers are obtained by differentiating the range-energy curves. At any energy, O, F, and Ne in Be and Ne in C have nearly the same dE/dx, while the dE/dx of O in C is the lowest. These derived dE/dx values generally agree with the directly measured values and are 2 to 30% higher than the LSS predictions. The derived dE/dx values are lower than the Firsov predictions by 2 to 42%, with the difference between theory and experiment tending to increase with increasing atomic number of the ion. (auth)

1210 STOPPING POWER OF THE ELEMENTS Z = 20 THROUGH Z = 30 FOR 5- TO 12-MeV PROTONS AND DEUTERONS. Andersen, H. H.; Hanke, C. C.; Simonsen, H.; Soerensen, H.; Vajda, P. (Atomic Energy Commission, Risoe, Denmark). Phys. Rev., 175: 389-95(Nov. 10, 1968).

The stopping power for 5 to 12-MeV protons and deuterons of Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, and Zn has been measured. For most of the materials, the accuracy is ±0.3%. For Ca, Sc, Cr, and Mn, which were rather difficult to handle, the results are somewhat less accurate. The results have been compared with published experimental data and with semiempirical tables by Barkas and Berger, by Bichsel, by Janni, by Serre, and by Williamson et al. Most of these are in agreement with our results within their stated accuracies. (auth)

1211 HYPERFINE INTERACTIONS IN THE J = 5 STATES OF ^{147}Sm AND ^{149}Sm. Robertson, R. G. H.; Waddington, J. C.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 46: 2499-2504(Nov. 15, 1968).

The hyperfine interaction constants $A_k(5)$ have been measured in ^{147}Sm and ^{149}Sm. Consideration of the k = 2 results together with Woodgate's values of $A_2(J)$ for J = 1 to 4 shows that his nonrelativistic treatment of the electric quadrupole interaction in samarium is adequate but that a relativistic one gives excellent agreement. The effect cannot be confused with a possible configuration interaction as it can in the case of the magnetic dipole interaction. Allowance for the effects of octupolelike second-order corrections and more precise computation of the dipole- and quadrupole-like corrections markedly affect the published results for the hyperfine constants in the lower J states, but the revision does not improve the agreement with the theoretical expressions. It would appear that Conway and Wybourne's analysis of the breakdown of L–S coupling in the nominally ^{7}F ground term is not adequate, particularly for the computation of the coefficient of the sC^4 term. (auth) (CANADA)

1212 FIELD METHODS OF CALCULATING THE POLARIZABILITY OF ATOMS. Malinowski, S. (Univ. of Lodz, Poland). Acta Phys. Pol., 34: 437-40(1968).

The Feynman diagram method is formulated for the problem of interactions of electric fields with atoms. A selection criterion of diagrams is given for calculation of multipole polarizability and hyperpolarizability. (auth)

1213 POSITRON ANNIHILATION IN SEMICONDUCTORS. Fieschi, R.; Gainotti, A.; Grezzi, C.; Manfredi, M. (Univ., Parma, Italy). Phys. Rev., 175: 383-8(Nov. 10, 1968).

Positron decay curves in various semiconducting elements and in the semimetals As, Sb, and Bi have been measured with a delayed coincidence system with 0.35 nsec full width at half-maximum prompt time resolution. The annihilation in ideal, pure semiconductors is found to be characterized by a simple exponential decay. The second low-intensity decay component may be entirely due to spurious effects. In nonintrinsic Si and Ge powders, however, a second decay component with considerable abundance is observed whose presence is assigned to unclear extrinsic processes. The intrinsic decay component in diamond, Ge, and Si can be interpreted as due to annihilation with the valence electrons, taking into account the screening effect through an evaluation of the dielectric constant. In S, Se, and Te, the effect of the electron charge distribution is dominant over the effect of electron polarizability. (auth)

1214 EXPERIMENTAL INVESTIGATIONS OF NEGATIVE ION COLLISIONS; ELECTRON DETACHMENT AND ION–MOLECULE REACTIONS. Martin, John David. Gainesville, Fla., Univ. of Florida, 1967. 83p.

Thesis.

Experimental studies of two important types of negative-ion–molecule collision processes are described: direct electron detachment and ion–molecule reaction. Total cross sections for the collisional detachment processes, $OH^- + He \rightarrow OH + He + e^-$, and $O_2^- + He \rightarrow O_2 + He + e^-$, have been measured in ion-beam–gas scattering experiments, at primary ion energies from 400 eV down to a few eV. In both cases, the variation of cross sections with collision energy shows the behavior typical of this process, rising rapidly with increasing energy in the region near threshold, and attaining a nearly constant value over the range 100 to 400 eV. From phase space considerations, which may be expected to apply in the region near threshold, it can be shown that the total cross section σ depends on the center-of-mass collision energy E_{CM} according to $\sigma^{1/2} \propto (E_{CM} + Q)$, where Q is the energy defect of the detachment process. Both collision systems were studied in detail in the threshold region, and both were found to follow the predicted behavior closely. Total cross sections for the ion–molecule reactions, $O^- + D_2 \rightarrow OD^- + D$, and $O^- + H_2 \rightarrow OH^- + H$, have been measured in a tandem mass spectrometer, at primary ion energies from a few eV to 69 eV for the $O^- + D_2$ system and to 119 eV for the $O^- + H_2$ system. In both reactions, the cross section rises rapidly with increasing energy in the region near threshold, peaks at approximately 10 eV, and then decreases monotonically thereafter. A pronounced isotope effect was observed; the maximum value of the cross section for OD^- formation was approximately 2.8 times the maximum for OH^- formation. From the observed onset for each reaction and from simple energy considerations, it appears that the OD^- and OH^- product ions are both formed (at low collision energies) in their ground electronic states, with vibrational/rotational excitation energies of about 0.65 eV. Several potentially useful theoretical approaches to the ion–molecule problem are reviewed briefly. The reactions $O^- + D_2 \rightarrow D^- + OD$, $O^- + H_2 \rightarrow H^- + OH$, and $O_2^- + H \rightarrow O^- + H_2O$ have also been observed, but cross sections for these have not yet been measured. (Diss. Abstr.)

1215 EXCHANGE EXCITATION OF HELIUM AND THE HYDROGEN MOLECULE BY LOW-ENERGY ELECTRONS. Cartwright, David Chapman. Pasadena, Calif., California Inst. of Tech., 1968. 312p.

Thesis.

The theory of rearrangement collisions involving composite particles is reviewed and the "post"–"prior" discrepancy is discussed. Two recent improvements to the Born–Oppenheimer approximation, the Ochkur (O), and Ochkur–Rudge (OR) approximations are reviewed. These approximations are then used to calculate the total cross section for the electronic excitation of molecular hydrogen by low-energy electrons. Excitations from the ground ($X^1\Sigma_g^+$) state to the first ($b^3\Sigma_u^+$) and second ($a^3\Sigma_g^+$) triplet states are treated. All nuclear motions are taken into account. It is found that the first triplet cross section is sensitive to the choice of the ground-state wave function whereas the second is not. The former is also sensitive to the quality of excited-state wave function used. The results using the (O) approximation are significantly larger than those of the (OR) approximation, and the maximum cross section occurs at a somewhat lower energy. Use of the

separated-atom approximation produces results significantly lower than those obtained by including all the multicenter terms in the scattering amplitude. The calculations are carried out using the zeta function expansion method and are quite lengthy. The sum of the first and second (OR) triplet cross sections agrees well with a recent approximate experimental determination of the cross section for electron-impact dissociation of H_2 into 2H. These approximations are also used to calculate the total cross sections for excitation of helium from the ground to the 2^3S and 2^3P states. These cross sections are sensitive to the ground- and excited-state wave functions used. The (OR) results agree well with the available experimental data for these excitations. The differential cross sections for these excitations are also calculated. Since there are no experimental data for the H_2 processes or for the 2^3P excitation in He, the quality of these calculations cannot be evaluated. The calculated angular distributions for the 2^3S excitation in He agree well with one set of experimental data but disagree with the other. The (OR) approximation is found to give quite good results for total cross sections but its value in predicting angular distributions cannot be evaluated until more experimental data are available. (Diss. Abstr.)

1216 ASSOCIATIVE AND DISSOCIATIVE IONIZATION OF GASES ON IMPACT OF METASTABLE ATOMS. Herce, John Austin. Gainesville, Fla., Univ. of Florida, 1967. 60p.

Thesis.

Measurements of mass spectra for the ionization of atoms and molecules on impact of excited atoms have been made using a mass spectrometer modified for molecular-beam experiments. The ions formed are extracted from the collision region at right angles to an incident beam of metastable helium atoms or metastable neon atoms excited by electron impact. Long-lived states of higher excitation are removed from the beam by a quenching field. Measurements of the relative ion abundances as a function of the exciting electron energy yield abundances for each metastable species. The known total ionization cross sections are used to calculate separate cross sections. There is a significant change in the relative amounts of associative and Penning ionization of argon and krypton with changing metastable-helium-beam composition. In each case the cross section for associative ionization is greater for $(2^3S_1)He^*$, while the Penning ionization cross sections are larger for $(2^1S_0)He^*$. In the metastable-neon–rare-gas systems, the relative amount of ionization is independent of beam composition. However, the relative amount of associative ionization in the Ne^* systems is approximately twice as large as that occurring in the analogous reactions involving He^*. These observations are consistent with a collision-complex mechanism postulated for these processes. The only ions produced by impact of metastable helium atoms on oxygen are O_2^+ and O^+. There is a marked difference in the relative amounts of O_2^+ and O^+ produced by each metastable state. This may be explained in terms of the number of energetically possible product channels available. The amount and type of fragmentation occurring in the $He^* + CH_4$ and $He^* + CD_4$ systems for a particular metastable state is the same within experimental error. All ions are observed that correspond to energetically possible fragmentation processes. However, the amount of fragmentation for the two metastable states is definitely different. Only the CH_3^+, CD_3^+, CH_2^+, and CD_2^+ ion abundances are greater for $(2^1S_0)He^*$. The mass spectra for these systems are quite different from those obtained by electron impact or photoionization. Evidently, the interaction potential of the colliding species is a major factor in determining the fragmentation patterns. (Diss. Abstr.)

1217 SINGLE ELECTRON CAPTURE CROSS SECTIONS OF THE $^2P_{3/2}$ AND $^2P_{1/2}$ STATE ARGON AND KRYPTON IONS. Williams, J. F. (Laval Univ., Quebec). Can. J. Phys., 46: 2339-46 (Nov. 1, 1968).

The ionization probability curves of argon and krypton atoms within 1 eV of threshold have been studied for electron impact with an average electron energy distribution of 0.035 eV (FWHM). In krypton, changes in the slope of the ionization probability curves occur at electron energies close to the spectroscopically observed autoionization levels between the $^2P_{3/2}$ and $^2P_{1/2}$ levels. Ions formed in such a manner are then used as primary ions in charge-transfer reactions. Total single-electron-capture cross sections have been measured for $^2P_{3/2}$ and $^2P_{1/2}$ state argon and krypton ions incident upon argon and krypton atoms, respectively. Upon the presumption of the applicability of the adiabatic hypothesis, it appears, for single-electron-capture reactions of krypton ions upon krypton atoms over the relative energy range 500 to 1500 eV, that (a) the reaction $^2P_{3/2} \rightarrow {}^2P_{3/2}$ is dominant over the reaction $^2P_{3/2} \rightarrow {}^2P_{1/2}$, (b) the cross section for the $^2P_{3/2} \rightarrow {}^2P_{3/2}$ reaction is greater than the $^2P_{1/2} \rightarrow {}^2P_{1/2}$ reaction cross section, and (c) little information can be deduced for the relative values of the forward and reverse $^2P_{3/2} \rightleftharpoons {}^2P_{1/2}$ reaction cross sections. (auth) (CANADA)

1218 APPROXIMATE CALCULATION OF THE CORRELATION ENERGY BETWEEN ELECTRONS. Santos C., Emilio (Univ., Costa Rica, Spain). An. Fis., 64: 177-93(May-June 1968). (In Spanish).

Given a variational solution of a two-electron problem, the approximate wave function is compared with the exact one when the distance between the electrons approaches zero. Several approximations are proposed in order to calculate the correlation energy. In particular, the external potential is replaced by an infinite rectangular potential well. The correlation energy is calculated as a function of the repulsion energy for paired and for unpaired electrons. The method is shown to give adequate values for paired electrons, but not for unpaired ones. Using a parabolic potential, a new calculation is done, which gives two sets of values of the correlation energy, one higher and the other lower than the previous one. The use of the results to estimate the correlation energy between two paired electrons may be interesting in calculations of localized bond energies in molecules. (auth)

1219 BAND-GAP EFFECTS IN THE STOPPING OF ^{72}*Ge ATOMS IN GERMANIUM. Chasman, C. (Brookhaven National Lab., Upton, N. Y.); Jones, K. W.; Kraner, H. W.; Brandt, Werner. Phys. Rev. Lett., 21: 1430-3(Nov. 11, 1968).

Measurements of the ionization losses of 10.0- to 30-keV ^{72}*Ge atoms in germanium show no evidence for a cutoff for particle energies less than 23 keV, as might be expected from adiabatic arguments concerning the effect of an energy gap in germanium. The ionization loss is consistent with Lindhard's conjecture that the electronic stopping power of heavy particles is proportional to the particle velocity even at energies far less than this cutoff energy. Any effective energy gap encountered by the germanium atoms moving in a germanium crystal is less than ~0.1 to 0.2 eV. (auth)

1220 EXPERIMENTAL DETERMINATION OF THE EFFECTIVE ATOMIC-SCATTERING FACTOR AND RIGID-LATTICE INTERFERENCE FUNCTION IN LOW-ENERGY ELECTRON DIFFRACTION. Lagally, Max G.; Webb, Maurice B. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 21: 1388-91(Nov. 4, 1968).

The elastic scattering of low-energy electrons from Ni is examined at temperatures where the multiphonon scattering is dominant. The effective atomic-scattering factor is extracted. The specularly reflected intensity is examined and the corrections necessary to determine the rigid-lattice interference function are discussed. (auth)

1221 ELECTRON SCATTERING FROM NITROGEN IONS. Turman, Bobby Neal. Austin, Tex., Univ. of Texas, 1968. 69p.

Thesis.

The experimental methods of gas-phase electron diffraction were adapted for use in ascertaining the molecular structure of the nitrogen ion N_2^+. An ion-deliver system utilizing a duoplasmatron ion source and electrostatic focusing was designed for this experiment. A beam of 45-kilovolt electrons was directed through the ion beam and the electron scattering was recorded photographically. The measured internuclear distance for N_2^+ was compared with the reported value in the literature as an indication of the accuracy of the procedure. (Disser. Abstr.)

1222 METASTABLE HYDROGEN ATOM PRODUCTION BY ELECTRON CAPTURE. Bayfield, James Edward. New Haven, Yale Univ., 1968. 208p.

Thesis.

Measurements were made of the cross sections for production of fast metastable hydrogen atoms in several electron-capture processes. The collisions studied were protons incident on atomic hydrogen, helium, argon, and molecular hydrogen gases. The proton energy range was 3 to 23 keV. The present studies of proton collisions with argon and helium were found to be in agreement with previous investigations. The results were used to calibrate the apparatus. Several different cross-section calculations for the process $H^+ + H(1s) \rightarrow H(2s) + H^+$ have appeared in the literature. A comparison of the present data with the theoretical results is made. The importance of excited-state production is included in a discussion of fast-proton collisions with hydrogen atoms. The total electron-capture process $H^+ + H(1s) \rightarrow H + H^+$ was reinvestigated. Some information related to the angular distribution of fast H(2s) produced in $H^+ - H(1s)$ collisions was also obtained. (Disser. Abstr.)

1223 DOUBLE IONIZATION MECHANISM. Amusya, M. Ya.; Kazachkov, M. P. (Ioffe Inst. of Physics and Tech., Leningrad). Phys. Lett., 28A: 27-8(Oct. 21, 1968).

A resonant mechanism for double ionization processes is proposed. (auth)

Cosmic Radiation

Refer also to abstracts 630, 822, 1586, 1648, and 1881.

1224 (AD-671553) STUDY OF THE INTENSITY TIME VARIATIONS OF THE COSMIC RADIATION. Final Report, November 1, 1962–October 31, 1967. Lockwood, John A. (New Hampshire Univ., Durham. Dept. of Physics). May 1968. Contract AF19(628)-2352. 229p. (AFCRL-68-0277). CFSTI.

The data-recording systems for the cosmic-ray neutron monitors at Durham and Mt. Washington were completely automated and neutron multiplicity systems added. The barometric pressure coefficients for both monitors were reevaluated. New differential response and specific yield functions were deduced for neutron monitors at sea level and mountain elevations with vertical cutoff rigidities in the interval $0.7 < P_c < 10$ GV. From the variation in the intensity recorded by neutron monitors from 1958 to 1965, the solar modulation was found to be described by (^-KP) for $0.5 < P < 50$ GV. An investigation was made of the solar-flare-associated cosmic-ray increase on Jan. 28, 1967, as recorded by the neutron monitors. The properties of three different types of boron-loaded liquid scintillators were investigated as possible detectors for measuring the neutron leakage flux from the Earth's atmosphere. Measurements of the neutron intensities above the atmosphere at rocket altitudes with a moderated ^{3}He neutron detector were completed. (auth) (USGRDR)

1225 (N-68-28598) COSMIC RAY PROPAGATION. Fichtel, C. E.; Reames, D. V. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 52p. (NASA-TM-X-63249; X-611-68-162). CFSTI.

The effect of matter on the cosmic-ray composition is considered in detail and the effect of diffusion is treated in the depth necessary to study some models of the cosmic radiation not previously considered in this manner. The results of these calculations show that there are some aspects of the experimental observations, such as the light-to-medium nuclei ratio as a function of energy, which are not consistent with any equilibrium model of the cosmic radiation which does not include a rigidity dependence in the mean free path. This conclusion is independent of the source spectrum assumed and is valid for a large class of source distributions. A series of possible explanations for the discrepancy between the observed experimental data and the theoretical predictions of the equilibrium picture are considered, and shown to be unlikely. Attention is turned to a simple nonequilibrium model, consisting of one fairly close single source superimposed on a general background. The calculations show that this picture leads to considerably better agreement with the experimental data, especially the light to medium nuclei ratio as a function of energy/nucleon. (auth) (STAR)

1226 (N-68-28697) COSMIC GAMMA-RAY SPECTRUM FROM SECONDARY PARTICLE PRODUCTION IN THE METAGALAXY. Stecker, F. W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1968. 24p. (NASA-TM-X-63254; X-641-68-219). CFSTI.

The form and intensity of the spectrum of cosmic γ rays resulting from the production and decay of π^0 mesons produced in metagalactic cosmic-ray p–p collisions is discussed. It is assumed that intergalactic space contains ionized hydrogen gas at a density of 10^{-2} cm^{-3} as indicated by recent x-ray observations in the 1.5 to 1.8-keV region. Using the Friedmann solution to the Einstein field equations of general relativity as a description of the expanding universe, a discussion is presented of the effects of red shift and spatial curvature on the generation and distortion of the local gamma-ray spectrum from the π^0 decay. Numerical calculations are presented for the Einstein–de Sitter solution, which is found to be an adequate model for these calculations. Various models are presented to represent the possible flux of metagalactic cosmic rays. In calculating metagalactic gamma-ray spectra, the effect of gamma-ray absorption at large red shifts is taken into account. (auth) (STAR)

1227 ROLE OF STOCHASTIC FIELDS IN ADMITTING LOW-ENERGY GALACTIC COSMIC RAYS TO THE SOLAR SYSTEM. Parker, E. N. (Univ. of Chicago). J. Geophys. Res., 73: 6842-5(Nov. 1, 1968).

Theoretical possibilities for free access of low-energy galactic particles to the lines of force in the solar wind are considered. It is concluded that the only simple explanation for the free access is the general stochastic nature of the magnetic lines of force of the fields beyond the orbit of Earth. The random walk of the field lines provides automatic free access across the mean field direction irrespective of the smallness of the cyclotron radius and the potential differences. (W.D.M.)

1228 COSMIC-RAY NEUTRON FLUX MEASUREMENTS ABOVE THE ATMOSPHERE. Lockwood, J. A.; Friling, L. A. (Univ. of New Hampshire, Durham). J. Geophys. Res., 73: 6649-63(Nov. 1, 1968).

Measurements were made of the neutron intensities above the atmosphere at rocket altitudes with a moderated ^{3}He neutron detector. The ^{3}He proportional counter was encased in a polyethylene moderator, and the moderator and neutron detector were surrounded by a ring of charged particle counters to discriminate against neutrons produced in the detector assembly by galactic and solar cosmic rays. Flights were made from 1965 to 1967 at 0, 20, 50, and 70° geomagnetic latitudes (λ). The neutron counting rates at these latitudes are 0.3, <0.7, 1.7, and 3.0 sec^{-1}, respectively. These counting rates can be converted to a neutron leakage flux in the energy range 10 to 5×10^6 eV by using the neutron detector calibration curve and Lingenfelter's calculated neutron energy spectrums at different latitudes. The neutron leakage flux is 0.08 ± 0.02 and 0.80 ± 0.10 neutrons/cm^2 sec at $\lambda = 0°$ and $\lambda = 70°$, respectively. This latitude effect is about 10/1, less than the 13/1 ratio calculated by Lingenfelter in 1963. For $\lambda < 50°$, the measured and the calculated neutron fluxes agree. (auth)

1229 NEUTRONS PRODUCED IN THE EARTH'S ATMOSPHERE BY THE COSMIC RADIATION. Sandie, William George. New York, New York Univ., 1968. 241p.

Thesis.

Balloon-borne experiments designed to measure the fast neutron flux in the atmosphere were carried out during the past solar minimum, 1965, from Ft. Churchill, Manitoba and from South Saint Paul, Minnesota. A measurement of the latitude variation of both fast and slow neutrons was made in an aircraft circumnavigating the Earth from Geographic pole to pole at two almost opposite longitudes. Both fast and slow neutron counting rates display an increase of about 600% from equator to pole at 245 gm/cm^2. The differential flux of neutrons in the energy range 1 to 10 MeV is compared with that obtained in balloon-borne measurements with the same detection system and with the work of others. An estimate of the effect of the aircraft environment on the measured flux is obtained. These data are then supplemented with transport calculations to determine the leakage flux and the production rate of radiocarbon, quantities which are not obtained directly from balloon-borne fast neutron measurements. The leakage fluxes obtained are significantly smaller than those obtained by others and indicate that the neutron albedo does not contribute to the population of the Van Allen radiation belts. An estimate of the global production rate of radiocarbon averaged over the past ten solar cycles was calculated to be 1.7 ± 0.3 nuclides/cm^2-sec which is not significantly different from the measured rate of disappearance from the atmosphere 1.9 ± 0.2. (Disser. Abstr.)

Direct Energy Conversion

Refer also to abstracts 1244 and 1380.

1230 (AD-670469) INVESTIGATIONS ON THE DIRECT CONVERSION OF NUCLEAR FISSION ENERGY TO ELECTRICAL ENERGY IN A PLASMA DIODE. Final Report No. 8, November 1, 1966–October 31, 1967. Leffert, Charles B.; Rees, David B. (General Motors Research Labs., Warren, Mich.). Contract Nonr-3109(00). 204p. (GMR-767). CFSTI.

This is the unclassified section of the final report dealing with fission-fragment-generated plasmas for thermionic energy conversion. Results of the past year's work are presented under three major headings, viz., (A) Reaction Kinetic Studies of Ar–Cs Plasmas, where the possible influence of a heteronuclear $ArCs^+$ ion is considered and rejected; (B) Calculation of Electron Temperatures in Plasma Produced by Fission Fragments, where it is discovered that a nonequilibrium electron temperature exists at the higher values of neutron flux; and (C) Electron Densities in Fission-Fragment-Induced Plasmas in Microwave Cavities, where much of the previous theories are collected, enlarged, and incorporated into a comprehensive set of computer codes which predict accurately electron densities in the Ne–Ar system. A survey is made of the past work, and some general comments and conclusions are offered on the present status and utility of the fission-fragment ionization scheme for use in thermionic diodes. (auth) (USGRDR)

1231 (AD-671355) MHD INDUCTION GENERATOR. Report No. P-3837. Dudzinsky, S. J.; Wang, T. C. (RAND Corp., Santa Monica, Calif. TRW Systems, Redondo Beach, Calif.). June 1968. 49p. CFSTI.

The general theory of MHD induction generators is reviewed in some detail. Several different approaches to the analysis of constant-velocity generators are summarized and compared, and a new mathematical model for a variable velocity generator

is presented, including digital computer solution for the theoretical performance. The velocity distribution and boundary layer losses are considered separately, and the problem of end effect is discussed qualitatively. Recent experimental results for both separately excited and self-excited MHD induction generators are summarized, and the future of MHD induction generators is discussed briefly. (auth) (USGRDR)

1232 (AD-671632) BOUNDARY AND END LOSSES IN MAGNETOGASDYNAMIC GENERATORS. Final Report, February 1, 1967–April 30, 1968. Hoffman, Myron A.; Hsu, Michael; Oates, Gordon C.; Reilly, James P. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). June 1968. Contract DAHC04-67-C-0026. 47p. (CSR-TR-68-8; AROD-6346:2-E). CFSTI.

One of the major potential loss mechanisms for magnetogasdynamic generators operating at high Hall parameters is that of eddy currents in the entrance and exit regions of the generator. An experiment was designed to test the concept of fluid injection as a means of suppressing the exit current loops. Theoretical studies indicate that if sufficiently small droplets on the order of 5 to 30 microns in diameter are introduced into the plasma flow, they would be very effective in quenching the electrical conductivity of the exit region through the mechanism of electron and ion capture. An experiment on a subsonic MGD channel employing axial injection of fine water jets did not result in a rise in open circuit voltage which could be positively attributed to the water injection. It is tentatively concluded that the water jets did not break up into sufficiently small droplets to quench the electrical conductivity in the exit region. (auth) (USGRDR)

1233 (N-68-30593) SOME INTERACTIONS OF POLYCRYSTALLINE TUNGSTEN ELECTRODES WITH CESIUM PLASMAS. Morris, James F. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1968. 17p. (NASA-TN-D-4745). CFSTI.

At thermionic diode temperatures, work functions of tungsten electrode surfaces depend strongly on positive ion sheaths between these electrodes and cesium plasmas. The present theoretic study demonstrates this effect for a plane field-modified emitter with a collisionless positive ion sheath in a thermally ionized plasma. The analysis covers temperatures from 1700 to 2600°K; plasma electron number densities of 10^{12}, 10^{13}, and 10^{14} cm^{-3}; and a bare work function of 4.59 V. Values for sheath voltages, work functions, and cesium arrival rates and coverages on tungsten result from equilibrium calculations. In addition to these variables, computations for elevated plasma electron temperatures yield net current densities. Throughout this work, the sheath drops lie below 1 V. And atom arrival rates approach total cesium arrival rates only at low temperatures and sheath voltages. (auth) (STAR)

1234 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC ELECTRICAL POWER GENERATORS. Freck, David Vernon (to Central Electricity Generating Board). British Patent 1,129,904. Oct. 9, 1968. Filed Aug. 4, 1965.

An MHD generator of the open-cycle type burning a fossil fuel is designed in which the electrical conductivity of the gases is increased, thereby enabling the exit temperature to be lowered. This is done by applying an electric field to the seeded hot gases before or as they enter the power-generating duct, the field being sufficient to give ionization greatly in excess of the thermal equilibrium value. For potassium-seeded combustion products, the required electric field has a magnitude E in volts per meter such that ET/P exceeds 1.5×10^8, where T is the temperature in °K and P is the pressure in atmospheres. (D.L.C.)

1235 IMPROVEMENTS IN OR RELATING TO MAGNETO HYDRODYNAMIC GENERATORS. Brocher, Eric. British Patent 1,129,913. Oct. 9, 1968. Priority date Aug. 26, 1965, Switzerland.

An MHD ac generator is designed in which the working fluid is heated by shock-wave compression and a cyclically controlled distributor is used to produce ac pulses. The generator comprises a pair of shock tubes, a reservoir of working fluid at one end of each tube, and a source of heated compressed auxiliary fluid connected to the other end of each tube via a cyclically controlled distributor, which is adapted to introduce the auxiliary fluid alternately into each tube and to discharge the fluid after a lapse of time. Parallel electrodes are provided around each tube near the end with the reservoir for the production of electricity. The operation and thermodynamic cycles of the generator are described. (D.L.C.)

1236 MAGNETOHYDRODYNAMIC GENERATION OF PULSATING ELECTRICITY. (to North American Aviation, Inc.). British Patent 1,130,658. Oct. 16, 1968. Priority date Nov. 4, 1965, United States.

A method is given for controlling the electric conductivity of a working fluid in an MHD generator to produce a pulsating electric current. The fluid is a two-phase fluid with liquid and vapor phases, and the method comprises periodically increasing the liquid content of the fluid to render it conductive. A generator using this method is described. (D.L.C.)

1237 HETEROGENEOUS FLOW GENERATING DEVICE. Pavlin, Cyrille Francois; Salmon, Jean Marcel (to Societe Bertin and Cie.). British Patent 1,130,885. Oct. 16, 1968. Priority date Nov. 18, 1964, France.

A heterogeneous MHD ac generator is designed in which the temperature limitations due to the wall materials are surmounted by means of a gas flow consisting of consecutive portions of a hot ionized gas and a cool unionized gas. The gas flow is equivalent thermally to a homogeneous gas at an intermediate temperature, but the gas has a higher conductivity owing to the exponential dependence on temperature. The heterogeneous flow is effected by means of two juxtaposed hydromagnetic or aerodynamic gates, controlled by electromagnetic or pneumatic means. Several embodiments of the gates and generator are described. (D.L.C.)

1238 RESEARCH ACTIVITIES ON MHD POWER GENERATION AT ELECTROTECHNICAL LABORATORY. Fushimi, Kozo (Electrotechnical Lab., Japan). Denki Shikensho Iho, 31: 129-35(Mar. 1967). (In Japanese).

In the Electrotechnical Laboratory, research on MHD power generation was started in 1961. Then, in 1962, the experimental dc MHD power generator No. 1, using a combustion gas, was constructed. Based on the results from No. 1 generator, No. 2, employing a combustion gas of light oil and oxygen, was constructed, and experiments were started in April 1966. The generator was designed for output of 1,000 kW and 5-min operation. A plan is being made for 100-hr operation. The research activities at Electrotechnical Laboratory are described in the following: No. 2 MHD power generator (combustion and exhaust systems, control of the combustion system, and electromagnets); combustion and power generation experiments; other research works (electrode materials and superconduction electromagnets); and future research works. (NSA of Japan)

1239 THE ANALYSIS OF MHD GENERATOR OPERATION BY MEANS OF VECTOR DIAGRAMS. Celinski, Z. (Inst. of Nuclear Research, Warsaw). Arch. Elektrotech. (Warsaw), 16: 1021-37(1967). (In Polish).

This comprehensive and profusely illustrated article describes a new method for analysis of the various electrical quantities of a dc MHD generator by means of vector diagrams. The geometrical loci of the ends of vectors describing electrical quantities are found within the complex plane by means of the generalized Ohm's law. These vectors vary with the changes in the Hall parameter, the load coefficient, and the changes in electrode connections. Derivations assume constant gas-dynamical parameters, the constancy of the magnetic field, a homogeneous current density, and a homogeneous electric field over the entire volume of the generator chamber. The proposed method offers a pictorial representation of the relationships between the various electrical quantities within the generator and leads in a simple way to the establishment of analytical expressions. Diagrams may be established using the direct readings from instruments without any other auxiliary calculations. (JPRS)

1240 EXACT SOLUTION FOR AXIALLY SYMMETRIC EQUILIBRIUM ELECTRON DENSITY DISTRIBUTIONS. Sajben, Miklos (California Inst. of Tech., Pasadena). Phys. Fluids, 11: 2501-2 (Nov. 1968).

A closed form general solution of Poisson's equation with an e^{χ} forcing term is given containing two arbitrary constants. Specialization of constants to two examples shows that the usual linearization ($e^{\chi} \approx 1 + \chi$) can be grossly misleading. (auth)

Fluid Physics

Refer also to abstract 1469.

1241 (AD-465580) APPROXIMATE SOLUTIONS FOR SKIN FRICTION AND HEAT TRANSFER IN MHD CHANNEL FLOWS. Technical Report on Project Squid. Moffatt, W. Craig (Virginia Univ., Charlottesville). June 1965. Contract Nonr-3623(00). 25p. (MIT-36-P). CFSTI.

Results are presented of a theoretical analysis of viscous and thermal boundary layer behavior on the electrically insulating wall of a rectangular MHD channel. Using momentum and energy integral approximations, steady, two-dimensional, constant-property, low magnetic Reynolds number flow is assumed with magnetic and electric fields imposed parallel to the short- and long-channel side-walls, respectively. Analytical and numerical

solutions are obtained for laminar skin friction and heat flux, and for turbulent skin friction, as a function of distance from the channel entrance. These results are compared with those for the case of no applied fields and possible reasons for the differences are set forth. (auth) (USGRDR)

1242 (AD-670158) RESEARCH ON PLASMADYNAMICS AND MAGNETOGASDYNAMICS. Final Technical Report, March 1, 1966-February 28, 1968. de Leeuw, J. H. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). May 1968. 11p. (AFOSR-68-1196). CFSTI.

Report summaries are included on the following topics: theory of spherical and cylindrical electrostatic probes, magnetohydrodynamic flow in the shock tube boundary layer, supersonic flow of compressible plasmas in a magnetic field, ionization processes in strong shock waves, and magnetohydrodynamic flow near a stagnation point. Other unpublished results are also summarized. (auth) (USGRDR)

1243 (AD-670526) SOME SIMILARITY TRANSFORMATIONS IN MAGNETOGASDYNAMICS. Report No. Scientific-53. Cap, Ferdinand; Floriani, Dietmar (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Mar. 30, 1968. Contract F61052-67-C-0014. 28p. (AFOSR-68-1187). CFSTI.

In order to get similarity solutions of some problems of magnetogasdynamics the mechanism of similarity transformations is applied to the corresponding equations. Five cases are treated: three two-dimensional boundary-layer theory cases (1) magnetic field perpendicular to the flow, unsteady case, (2) the same, but steady, (3) the steady problem with arbitrary magnetic field; a three-dimensional boundary layer problem, also with arbitrary magnetic field; and, without boundary layer approximation, the general three-dimensional unsteady MGD-equations. (auth) (USGRDR)

1244 (AD-670527) EXPERIMENTAL ELECTRODE CURRENT DISTRIBUTIONS IN MHD CHANNELS. Kurz, J. L. (Stanford Univ., Calif. Inst. for Plasma Research). Apr. 1968. Contract AF49(638)-1695. 127p. (SU-IPR-230; AFOSR-68-1298). CFSTI.

The distribution of current on the electrodes of a single-pair MHD channel was investigated experimentally. The experiments were performed with a flowing, atmospheric-pressure, alkali-metal-seeded argon plasma at temperatures between 1980 and 2150°K for Hall parameter values up to seven. Two electrode configurations were investigated; one with the electrodes projecting into the flowing plasma, the other with the electrodes flush with the channel wall. Qualification measurements showed that the plasma free-stream conditions were uniform across the channel and in agreement with equilibrium calculations. Results for the anode current distribution were in all cases in good agreement with the theoretical predictions. The cathode current distribution was found to agree less well with the predictions. It was observed that the cathode current distribution for flush electrodes was considerably more uniform than for projecting electrodes. The anode voltage drop was consistently a small fraction of the total applied voltage for both electrode configurations. In contrast, the cathode voltage drop for the flush electrode channel was about four times that for the projecting electrode channel and constituted nearly 50% of the total applied voltage. The cathode voltage drop was found to correlate reasonably well with the Schottky equation. Measurements made of the root-mean-square voltage fluctuations between voltage probes were consistent with the presence of magnetoacoustic and electrothermal waves. (auth) (USGRDR)

1245 (N-68-30732) PROBLEMS ON THE EXISTENCE OF OPEN- AND CLOSED-FORM SHOCKS IN MAGNETOHYDRODYNAMIC SHOCK WAVES. Jen, Ch'en. Translated from Wu Li Hsueh Pao, 22: 1098-1102(1966). 9p. (NASA-TT-F-11699). CFSTI.

The basic equations for magnetohydrodynamic shock waves are presented, assuming that suitable, fixed coordinates can be selected on the wave plane. Limitations on the possibility of formation of open-form shock waves are presented. The mathematical discussion presented shows that the adiabatic equations of open-form and closed-form shocks cannot be the same as the equation for normal shock waves or magnetohydrodynamic shock waves. The data indicate that middle shock waves can occur more easily than open-form shocks. The middle shock waves would be of the unstable type. They would split into many shock waves with greatly decreasing intensity. (auth) (STAR)

1246 CIRCULATION AND RELATED TOPICS IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Yau, Hon-fai. University Park, Pa., Pennsylvania State Univ., 1967. 84p. Thesis.

The relativistic effects of two mathematically related problems are investigated. The first one is the condition of the constancy of circulation in a relativistic infinitely conducting fluid in the presence of an electromagnetic field. Secondly, the frozen-in properties of the magnetic field lines in the relativistic MHD problems are discussed. In order to simplify the mathematical complications, a simple model of ideal fluid which is nonviscous, non-heat-conducting and infinitely electric-conducting is employed. (TSS) (Disser. Abstr.)

1247 APPLICATION OF OPTIMIZATION TO EPIHYDRODYNAMICS. v. Krzywoblocki, M. Z. (Michigan State Univ., Ann Arbor). Sci. Tech., Ser. Mecan.-Appl., 13: 17-39(1968).

The application of optimization techniques to the field of epihydrodynamics is demonstrated. First, the problem of determining the motion into which a liquid initially at rest in either (a) the absence of gravitational forces, or (b) in a uniform gravitational (or possibly equivalent inertial) field, is set when the gravitational field is suddenly applied in case (a) or suddenly ceases to act in case (b) is attached. The liquid is contained in an open tank (two vertical half-planes and a bottom), is electrically conducting and magnetically permeable, and is subject to the action of an electromagnetic field. The proposed technique of solving the electromagnetohydrodynamic system of non-linear partial differential equations is that of successive approximations. The first and second steps of the successive approximation are discussed. The higher order approximations follow the same pattern as that of the second order. The proposed technique may be suitable for handling by means of high-speed computers. The problem of gravitational effects upon the stability of a fluid layer heated from below is studied. Future problems include (a) application of optimization techniques to partial differential equations (p.d.e.); (b) lack of proofs of the validity of various optimization techniques for the systems of p.d.e.; (c) difficulties encountered in solutions of optimized p.d.e. systems on computers; (d) possibility of applying the techniques of the reduction of number of independent variables to overcome the difficulties with many variables on computers. (BBB)

1248 THEORY OF RAYS IN RELATIVISTIC HYDRODYNAMICS AND MAGNETOHYDRODYNAMICS. Lichnerowicz, Andre (College de France, Paris). Ann. Inst. Henri Poincare, Sect. A, 7: 271-302(1967). (In French).

The theory of rays (or bicharacteristics) corresponding to the types of waves detected in relativistic hydrodynamics and magnetohydrodynamics is developed. The waves are studied in terms of tensor distributions associated with the discontinuities of the derivatives of the physical parameters. The first part of the study is devoted to the necessary preliminary mathematics relative to these distributions; the optics are close to the Pichon optics. The infinitesimal discontinuity operator δ can be defined and its principal properties determined. Hydrodynamics and magnetohydrodynamics are then examined. For the rays associated respectively with the sonic, magnetosonic, and Alfvén waves, the fundamental property of the rays concerning the propagation of the infinitesimal discontinuities is established. The results show that, although the direction of the rays remains invariant by the infinitesimal discontinuity operator for sonic and Alfvén waves, this is not the case for the rays associated with magnetosonic waves. Apart from the case where the magnetic field is tangential, there is invariance for these waves of the direction of the waves only in the singular case (S). In this case the cone of magnetosonic waves has two double generators. (tr-auth)

1249 UNSTEADY HYDROMAGNETIC FLOW NEAR A HORIZONTAL FLAT PLATE WITH SUCTION. Pop, Ioan (Univ. Babes-Bolyai, Cluj). Stud. Cercet. Mat., 20: 1183-8(1968). (In Rumanian).

Hydromagnetic flow is considered with suction of a viscous incompressible and electrically conducting fluid near an accelerated motion of an infinite flat plate in the presence of a uniform magnetic field fixed relative to the fluid. The distribution of the velocity is determined by the expansion in series of the hydromagnetic parameter mt, in which the first term represents the (similarity) flow in the nonmagnetic case. In the case of the impulsive motion and uniform accelerated motion respectively, the solution is graphically represented for various values of suction parameter η_0 and for various values of hydromagnetic parameter. (auth)

1250 METHOD OF FINITE DIFFERENCES FOR RESOLVING ONE-DIMENSIONAL UNSTEADY PROBLEMS OF MAGNETOHYDRODYNAMICS. Samarskii, A. A.; Volosevich, P. P.; Volchinskaya, M. I.; Kurdyumov, S. P. Zh. Vychisl. Mat. i Mat. Fiz., 8: 1025-38(Sept.-Oct. 1968). (In Russian).

A numerical method is presented for resolving equations of magnetohydrodynamics that were used for calculating the T-layer

effect (a high-temperature electric conducting self-containing layer of gas appearing in a certain section of mass due to Joule heating). It was assumed that thermal and electric conductivity factors are arbitrary functions of the temperature and density. The suggested method and respective programming enabled resolving problems of various boundary conditions and equations of state of the mass. (R.V.J.)

1251 MAGNETOFLUIDMECHANIC LAMINAR NATURAL CONVECTION: AN EXPERIMENT. Papailiou, D. D.; Lykoudis, P. S. (Purdue Univ., Lafayette, Ind.). Int. J. Heat Mass Transfer, 11: 1385-91(Sept. 1968).

An experiment is described in which the effect of a magnetic field on laminar natural convection of Hg was studied. The geometry was that of a vertical isothermal hot plate with a magnetic field acting perpendicularly. The magnetic field imposed externally was designed as suggested by the theoretical investigation for the existence of a similarity solution. This suggestion is that the magnetic flux should vary as $x^{-\frac{1}{2}}$ along the vertical direction, x. Temperature profiles under the above conditions were measured for different magnetic field strengths, and the existence of similarity solutions was fully established by the experiment. (auth) (UK)

1252 STABILITY OF A PERFECTLY CONDUCTING LIQUID JET IN THE PRESENCE OF A MAGNETIC FIELD. Chakraborty, B. B. (Panjab Univ., Chandigarh, India). Phys. Fluids, 11: 2402-5(Nov. 1968).

The stability of a cylindrical jet of a perfectly conducting, incompressible, and inviscid fluid in the presence of an axial magnetic field is studied for both axisymmetric and asymmetric disturbances. It is found that the jet becomes stable against disturbances of any wavelength when the magnetic field strengths are sufficiently high both inside and outside the jet, so that the Alfvén wave velocities at these places are greater than the undistrubed velocities of the fluid there. When the magnetic field strengths are not sufficiently high, the jet becomes unstable, and the critical wavenumber for those disturbances at which the instability first sets in is calculated in the axisymmetric case with the fluid outside the jet taken to be at rest. (auth)

1253 INFLUENCE OF AN AXIAL MAGNETIC FIELD ON THE STEADY LINEAR EKMAN BOUNDARY LAYER. Gilman, Peter A.; Benton, Edward R. (Univ. of Colorado, Boulder). Phys. Fluids, 11: 2397-2401(Nov. 1968).

A hydromagnetic version of the Ekman boundary layer is developed in a simple form in order to study how the geophysically important Ekman suction velocity is affected by magnetic fields. The problem treated consists of a viscous, incompressible, conducting fluid in the presence of an infinite, flat, insulating boundary which rotates at speed Ω_0. Outside the boundary layer, the fluid rotates uniformly with speed $\Omega_1 = \Omega_0 (1 + \epsilon)$, and there is a uniform magnetic field aligned with the rotation axis. An expansion in powers of ϵ, the Rossby number, together with von Kármán similarity, leads to an exact solution which to first order in ϵ, describes a continuous transition between pure Ekman flow and a rotating analog of Hartmann flow. The magnetic field is found to inhibit Ekman suction; yet, such a boundary layer may still exert a strong influence on the outer flow because of a new feature that replaces the suction, namely an induced axial current outside the boundary layer. This "Hartmann current," not present in the conventional Hartmann problem, owes its existence to the fluid rotation. (auth)

Geophysics

Refer also to abstracts 1126 and 1200.

1254 (AD-670530) AN EXPERIMENTAL DETERMINATION OF THE DYNAMIC VISCOSITY OF ATMOSPHERIC ARGON FROM 3500 TO 8500 DEGREES KELVIN. Aeschliman, Daniel P. (Northwestern Univ., Evanston, Ill. Gas Dynamics Lab.). Mar. 1968. Contract AF49(638)-1533. 200p. (NU-GDL-B-1-68; AFOSR-68-1210). CFSTI.

A direct-current wall-stabilized arc, constrained to the axis of a precision-bore Vycor tube, was employed for the determination of the dynamic viscosity μT_g of argon at atmospheric pressure over the heavy-particle temperature range from 3500 to 8500°K. It was found that except for a slightly elevated electron temperature, the arc could be expected to operate in local thermal equilibrium (LTE) along the arc axis. Spectroscopic measurements gave an electron temperature of 9300°K along the axis. Allowing for kinetic nonequilibrium, the heavy-particle temperature along the axis was calculated to be 8020 ± 150°K. The T_g (r) profile was found to be consistent with other arc parameters which could be measured experimentally, in particular, the total mass flow and the total arc current. (auth) (USGRDR)

1255 (N-68-25719) HYDROGEN EMISSION IN PULSATING AURORAS. Eather, R. H. (Rice Univ., Houston, Tex. Dept. of Space Science). 1967. 29p. (NASA-CR-88231). CFSTI.

Simultaneous measurements of electron-excited emissions and Hβ emission during three pulsating auroras (5 to 15-second period) showed no detectable Hβ pulsations. An upper limit for any Hβ modulation is about $^1/_8$ the percentage modulation of the electron-excited emission. If this result is true in general, it limits possible pulsation mechanisms to those involving plasma instabilities. A single observation of a pulsating aurora with a 50 to 200-second period is also reported; both Hβ and electron-excited λ5577 O I were modulated to the same extent. It is believed a different mechanism was responsible, possibly loss-cone modulation by hydromagnetic waves near the equatorial plane. (auth) (STAR)

1256 (N-68-25720) SOME RECENT RESULTS ON THE MEASUREMENT OF HYDROGEN AND HELIUM EMISSIONS IN THE AURORAL ZONE. Eather, R. H. (Rice Univ., Houston, Tex. Dept. of Space Science). 1967. 20p. (NASA-CR-83315). CFSTI.

A photometric scanning system with a sensitivity of 0.05 R/A failed to detect any λ5876/He I emission in the auroral zone. An emission feature in this region was found to be part of the 8-2 hydroxyl system. Upper limits of 0.02 to 0.003 are placed on the λ5876/Hβ ratio and the corresponding α particle/proton ratios are calculated as functions of particle energy. The ratios of the intensity of λ3914 N_2^+, λ4709 N_2^+, λ5577 O I, and λ6300 O I to the Hβ intensity were measured in proton-excited auroras. The ranges in measured ratios (described by one standard deviation from the mean) are 10.0 to 17.5, 0.9 to 1.3, 9.0 to 12.5, and 2.5 to 3.3 respectively; and these are in reasonable agreement with theoretical predictions. Recommended values to use for the ratios are 17.0, 1.0, 10.0, and 3.0 respectively. The results may be used to estimate the relative importance of proton and electron excitation in auroras. (auth) (STAR)

1257 (N-68-25755) DYNAMICS OF A CHARGED PARTICLE IN A SPIRAL FIELD. Burns, Joseph A.; Halpern, Gerald (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 29p. (NASA-TM-X-63230; X-641-68-189). CFSTI.

The adiabatic guiding-center motion of an energetic charged particle in an idealized representation of the interplanetary magnetic field is discussed. Expressions are presented for all drift-velocity components. A comparison of these drifts establishes that, for the cases of physical interest, the electric drift velocity is by far the dominant drift velocity. Considering only the electric drift velocity, an expression is derived for the time of flight of a particle leaving the Sun. Similarly, it is shown analytically that the particles remain attached to the same field line on which they left the Sun, thus indicating their point of origin. High-energy unscattered particles are shown to be rapidly channeled down the field lines, resulting in a highly anisotropic particle distribution in the vicinity of the Earth. These analytic results are in excellent agreement with numerical integration of complete drift equation and compare favorably with the experimental data. (auth) (STAR)

1258 (N-68-25756) LATITUDINAL VARIATION OF THE COMPOSITION OF THE TOPSIDE IONOSPHERE: FIRST RESULTS OF THE OGO-2 ION SPECTROMETER. Taylor, H. A. Jr.; Brinton, H. C.; Pharo III, M. W.; Rahman, N. K. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 43p. (NASA-TM-X-63221; X-621-68-202). CFSTI.

Direct measurements of a pronounced latitudinal variation in the exospheric ion composition have been obtained from a radio frequency ion spectrometer experiment. Measurements of thermal positive ions show that in the altitude range of 415 to 1525 km the major ions are O^+ and H^+. Evidence of pronounced solar and geomagnetic control of the ion distributions is further examined by translating the data along magnetic field lines to both a constant 1000-km reference level and the dipole equator. The high-latitude ionosphere is marked by two dominant features — first, a major trough in $n(H^+)$ and $n(He^+)$, and secondly, a variable poleward peak in which the total ion concentration, N_i, approaches 10^4 ions/cm³ near 80° dipole. The pronounced light ion trough, which correlates well with the whistler cutoff, is believed to mark the high-latitude boundary of the thermal plasma. That the polar exosphere is decoupled from the plasmasphere and is probably linked with the solar wind–magnetospheric tail system is also suggested. (auth) (STAR)

1259 (N-68-25775) TECHNIQUE FOR SIMULATING THE IONOSPHERIC PLASMA. Burrowbridge, Donald R. (National

Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 24p. (NASA-TM-X-63226; X-325-68-172). CFSTI.

Thesis. Submitted to Catholic Univ. of America, Washington, D. C.

Techniques and hardware are described by which an environment simulating the plasma of the ionosphere can be produced. This environment was developed to determine the operating characteristics of spacecraft systems and experiments in the presence of charged particles, and to determine the effectiveness of electrostatic shields against the charged particles. The plasma is produced by a low-energy electron beam ionizing the residual gas or introduced gas in a vacuum chamber. The relative motion between an orbiting spacecraft and the ionized media is included by accelerating the ions through a screen into the test volume. Ion beams 40 inches in diameter have been produced to simulate the electron and ion densities of the F region. Tests to date have shown open cathode photomultiplier tubes particularly vulnerable to charged particles as indicated by noise and transients in the signal circuits of the tubes. Plasma energies and densities are determined by retarding potential analyzers and Langmuir probes. (auth) (STAR)

1260 (N-68-26966) SATELLITE AND ROCKET OBSERVATIONS IN THE AURORAL ZONE. Maehlum, Bernt N. (Rice Univ., Houston, Tex. Dept. of Space Science). [1967]. Contract NAS-6-1061. 33p. (NASA-CR-88066; CONF-670974-2). CFSTI.

From Symposium on Aurora and Magnetic Storms, Sandefjord, Norway.

A brief survey of the particle climate in the auroral zone is followed by an analysis of variations in particle energy spectra and pitch-angle distributions during individual days. Evaluated are rocket and satellite observational data and their relationships to auroral luminosity, upper atmosphere ionization, etc. Results show that during quiet nights, electron fluxes are more isotropically distributed over large latitude intervals and that the fluxes of precipitating electrons are highest in the morning. (STAR)

1261 (N-68-27385) ON THE VARIETY OF PARTICLE PHENOMENA DISCERNIBLE AT THE GEOSTATIONARY ORBIT VIA THE ATS-1 SATELLITE. Freeman, J. W. Jr.; Maguire, J. J. (Rice Univ., Houston, Tex. Dept. of Space Science). [1967]. Contract NAS-5-9561. 27p. (NASA-CR-95215; CONF-670974-1). CFSTI.

From Symposium on Aurora and Magnetic Storms, Sandefjord, Norway.

The three most salient phenomena that have been observed with the Rice University ion detector aboard the ATS-1 synchronous orbit satellite were studied. These phenomena are: a gross pre-post/midnight asymmetry in the enhanced energetic charged particle fluxes observed on the night side of the Earth; a magnetopause penetration to 6.5 R_E with the subsequent detection of discrete clouds of energetic particles executing repeated longitudinal drift about the Earth; and bursts of very-low-energy ($E < 50$ eV) highly directional positive ions tentatively associated with hydromagnetic transients. Each of these phenomena are described in sufficient detail to illustrate the prominent facts. (auth) (STAR)

1262 (N-68-27386) ANOMALOUS PARTICLE FLUXES AT THE SYNCHRONOUS ORBIT, JANUARY 13-14, 1967. Freeman, J. W. Jr.; Maguire, J. J. (Rice Univ., Houston, Tex. Dept. of Space Science). Aug. 1967. Contract NAS-5-9561. 21p. (NASA-CR-95216). CFSTI.

On January 13 and 14, 1967, an intense magnetic storm occurred. Within three hours after the beginning of the main phase, a positive impulse was seen at low-latitude stations. Coincident with this impulse anomalously high anisotropic particle fluxes were observed by the low-energy ion detector aboard the synchronous satellite ATS-1. These particles are consistent with the interpretation that the magnetopause was pushed inward beyond 6.5 R_E during this event. Subsequent to this anisotropic flux observed in the magnetosheath, there occurred three separate isotropic particle bursts in the pre-midnight hemisphere, separated in time by about two and one-half hours. High time resolution of the first two bursts gives evidence of a remarkable coherence, indicating that the detector may have observed a nearly monoenergetic cloud of plasma drifting essentially intact around the Earth for at least two orbits. (auth) (STAR)

1263 (N-68-28248) PROPAGATION OF THE SUDDEN COMMENCEMENT OF 8 JULY 1966 TO THE MAGNETOTAIL. Sugiura, M.; Skillman, T. L.; Ledley, B. G.; Heppner, J. P. (National Aeronauticx and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1968. 31p. (NASA-TM-X-63247; X-612-68-235). CFSTI.

The solar flare of 7 July 1966 produced a sudden commencement on the Earth at 2102 UT on 8 July. The OGO-3 satellite observed a sudden increase in the magnetic field in the magnetotail following the sudden commencement. Using the IMP-3 and Explorer 33 observations of the interplanetary shock that caused the sudden commencement, the propagation of the field increase from the front side of the magnetosphere to the tail is discussed. It is shown that the magnetospheric propagation of this perturbation toward the tail is faster than the propagation of the interplanetary shock just outside the bow shock. Based on the observations by OGO-3, the ground observations, and those made in interplanetary space by IMP-3 and Explorer 33, the interplanetary shock speed is estimated to be approximately 500 km/sec, with an Alfvén Mach number for the shock about 1.2. This is considerably lower than the 700 km/sec deduced from plasma measurements on Explorer 33. It is concluded that: (1) the observed magnetic field increase in the tail is unlikely to be due to an increased lateral pressure of the post-shock solar wind gas from the side of the tail; and (2) the transfer of additional polar magnetic flux to the tail due to the increase in the solar wind pressure on the front side of the magnetosphere can account for the tail field increase. (auth) (STAR)

1264 (N-68-28336) INCOMING LOWER-ENERGY PARTICLES AND THEIR ASSOCIATION WITH AIRGLOW AND AURORAE. O'Brien, Brian J. (Rice Univ., Houston, Tex. Dept. of Space Science). 1967. 21p. (CONF-670729-1; NASA-CR-85658). CFSTI.

From IQSY/COSPAR Symposium, London, England.

Measurements of atmospheric electron and proton precipitation from ground-based devices as well as those carried by balloons, rockets, and satellites are reviewed. The occurrence of similar auroras at magnetically conjugate points and the implied unknown acceleration mechanism(s) are discussed. Balloon- and rocket-borne experiments have shown that the auroral precipitation occasionally exhibits a periodicity possibly indicative of complex wave–particle interactions in the magnetosphere. Definitive experiments to resolve many of the unknown particle acceleration phenomena are discussed. Evidence is cited to demonstrate that airglow is caused by photochemical reactions, not by particle bombardment. (STAR)

1265 (SC-DC-68-2407) SOME CHARACTERISTICS OF THE RECOVERY OF THE UPPER ATMOSPHERE FROM VERY-HIGH LEVELS OF EXCESS IONIZATION. Hudson, Frank P. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1968. Contract AT(29-1)-789. 12p. (CONF-680923-1). Dep. CFSTI.

From 3rd Aeronomy Conference, Urbana, Ill.

A calculational model involving simultaneous solution of twenty coupled differential equations has been used to determine some of the characteristics of the recovery of the upper atmosphere from very high levels of charge perturbation. The time dependence of the densities of a number of positive and negative ionic species and electrons, under a variety of initial conditions, is shown. The altitude range is from 50 to 100 km and the levels of initial ionization, I_0, are selected in the range 10^{-6} to 10^{-1}. The relative importance of various electron removal processes as a function of I_0 and altitude is shown, and the contribution of negative ions as later-time sources of electrons is demonstrated. (auth)

1266 ON THE THEORY OF VLF PROPAGATION FOR A STEP MODEL OF THE NONUNIFORM EARTH–IONOSPHERE WAVEGUIDE. Wait, J. R. (Environmental Science Service Administration, Boulder, Colo.). Can. J. Phys., 46: 1979-82 (Sept. 1, 1968).

Reflections in a curved model of the Earth–ionosphere are considered for the case where the reflecting height is discontinuous. Explicit formulas are given for calculating the conversion coefficients for an incident mode of order m, a reflected mode of order n, and a transmitted mode of order q. It is shown that the usual neglect of reflected modes has some justification. (auth) (CAN)

1267 THE NATURE OF SPREAD-F IRREGULARITIES IN ANTARCTICA. Bowman, G. G. (AVCO Corp., Lowell, Mass.). Aust. J. Phys., 21: 695-714(Oct. 1968).

Some characteristics of spread-F ionograms from the Antarctic region are discussed. Very disturbed periods, such as when magnetic storms are in progress, have been neglected in this analysis. Two important characteristics are the frequent occurrence of resolved as well as diffuse traces, and the appearance from time to time of an enhanced trace which seems to be produced by signals that arrive from directions close to the magnetic field direction. Two independent sets of spread-F traces are reported. Several possible models are examined and some ray tracing performed. The analysis favors a model that incorporates kinking of the contours of equal ionization density to produce "wavelengths" in the ionospheric structure of some tens of kilometers. Because of the similarities at mid- and high-latitude regions, it is suggested that similar mechanisms are operating at both regions to produce spread-F. (auth)

1268 ORIGIN AND PROPAGATION OF ACOUSTIC-GRAVITY WAVES DUCTED IN THE THERMOSPHERE. Wickersham, A. F. (Stanford Research Inst., Menlo Park, Calif.). Aust. J. Phys., 21: 671-80(Oct. 1968).

The theory of acoustic-gravity waves in a thermoclinal atmosphere shows that damping decreases as the thermal gradient increases. If the thermal gradient is large enough it offsets the increase in amplitude caused by upward propagation into a region of decreasing ambient density and the motion is completely undamped, neglecting viscosity. Thus it appears that long-distance propagation can occur in the principal duct at 150-km altitude, where the thermal gradient is almost large enough to eliminate nonviscous damping. It is shown that thermal perturbation of the principal duct by the long winter-solstice sunrise in the polar regions is a source of ducted gravity waves consistent with the seasonal variations in directions of traveling ionospheric disturbances (TID's) observed in Australia. The observed tilts of TID's are compared with theory and can be used to determine the period of a disturbance. The effect of ionospheric charge equilibration is discussed briefly, and a leaky-duct gravity wave model is proposed which reconciles the observations of tilted wave fronts and long-distance propagation. (auth)

1269 LOW-LATITUDE AURORAE AND M ARCS. Truttse, Y. L. (Inst. of Physics of the Atmosphere, Moscow). Nature (London), 220: 150(Oct. 12, 1968).

It is known that the main emission of low-latitude aurorae is that of atomic oxygen at 6300 Å, so that low latitude aurorae are always red, and low latitude arcs in emission at 6300 Å during intense geomagnetic storms (M-arcs) have been reported. It is demonstrated that the M-arc is simply an extreme manifestation of the low-latitude aurora, since the red oxygen emission develops a more pronounced peak in latitude with increasing magnetic disturbance. The intensity of the emission at high latitudes does not reach such large magnitudes as at lower latitudes. The concentration of red emission in a narrow latitude during strong geomagnetic disturbances is probably an argument in favor of its excitation by hydromagnetic oscillations of magnetospheric plasma along geomagnetic lines of force of the same length. (UK)

1270 NORTH–SOUTH IONOSPHERIC DRIFTS NEAR THE MAGNETIC EQUATOR. Bamgboye, D. K. (Univ. of Ibadan, Nigeria); Lyon, A. J. Nature (London), 220: 152-4(Oct. 12, 1968).

The four-aerial array at Ibadan is described, together with typical amplitude fading records. Diurnal variations of the northward component of the drift velocity, V_N, are shown for June 21, 1967, and diurnal variations of the median V_N for May 1966, May 1967, and June 1967; also diurnal variations of V_N for the four seasons, and annual variations of night means and mid-day values of V_N. It was found possible to estimate the orientation and axial ratio of the irregularities, as well as drift velocity components corrected both for anisometry of the diffraction pattern and for the changing of the pattern as it moves; also the characteristic velocity V_c, and the scale size, L, of the ground pattern. In most of the observations the principal axis of the characteristic ellipse, representing the approximate mean shape of the observed irregularities, was directed within a few degrees of magnetic north. The mean direction was significantly to the west of magnetic north on the ground, by ~1.5°. The data given are only for the F region; E region results are similar to the F region by day. It was found that the diurnal variation of N–S drift was remarkably consistent from year to year. Broad conclusions from the data are summarized. The observation of strong N–S drift velocities with marked seasonal characteristics and consistent diurnal variations so near the magnetic equator is surprising, because the theory of electrodynamic drifts, although predicting correctly the general behavior of the eastward component, predicts an almost zero northward component in this region. (UK)

1271 NEW METHOD OF FORECASTING GEOMAGNETIC ACTIVITY USING FEATURES OF THE SOLAR CORONA. Bednarova-Novakova, B.; Halenka, J. (Geophysical Inst., Prague). Nature (London), 220: 250-1(Oct. 19, 1968).

It has been shown that a geomagnetic disturbance will occur only when a coronal formation is directed towards the Earth, and from the point of view of geomagnetic effects coronal streams and minimum type corona are significant. The coronal stream above the center of the solar disk is followed by a geomagnetic disturbance either with a sudden commencement, provided the stream was formed in the central region, or a gradual commencement if an already existing coronal stream is moved to the center of the disk by the solar rotation. A similar effect occurs if the peak of the minimum type corona passes through the center of the disk. If a minimum type corona is formed directly over the central meridian, as a result of the decay of perturbing local magnetic fields, a geomagnetic disturbance with a sudden commencement follows. If the minimum corona formation has already been formed before reaching the central meridian a geomagnetic disturbance with a gradual commencement follows after passage through the central meridian. These findings are discussed in relation to the forecasting of geomagnetic activity. Test forecasts were made for a total of 737 days covering the period Sept. 1959 to Dec. 1967, with a reliability of 90%. In the period between April 1964 and Nov. 1967, ninety-four days with an expected disturbance and 42 days with expected periods of geomagnetic calm were covered by the forecasts. This method of forecasting can be used for the existence or nonexistence of plasma streams in interplanetary space above the visible solar hemisphere. (UK)

1272 INVESTIGATION OF QUASI-PERIODIC VLF EMISSIONS AND THEIR RELATION TO GEOMAGNETIC MICROPULSATIONS. Kitamura, T. (Doshisha Univ., Kyoto); Jacobs, J. A.; Watanabe, T.; Flint, R. B. Nature (London), 220: 360-1(Oct. 26, 1968).

Vlf emissions whose signal strength changes with a period longer than the "two-hop whistler" group delay are referred to as QP vlf emissions. About 400 QP events were observed in the vlf emission data recorded at Byrd Station in Antarctica during Feb. to April and Sept. to Nov. 1964. The vlf emissions were recorded in the frequency range 1 to 2.4 kHz and in a narrow band centered on 8 kHz, and observations were occasionally made at 400 Hz. QP's were observed on the two lower-frequency channels, though not necessarily simultaneously; they never appeared on the 8-kHz channel. They were observed mostly when the station was on the daylight side of the Earth, and their periods ranged from 10 sec to about 2 min, and occasionally up to 10 min. QP events are often, but not always, associated with geomagnetic micropulsation activity, and a chart of GP-associated QP events observed at Byrd Station is shown. Spectral structures of QP's were examined for 22 events observed at three Antarctic stations during 1964–66, and GP association investigated. There was strong indication that for some types of QP the period is dependent on the vlf signal strength, being shorter for stronger emissions. A further type was a diffuse emission referred to as "lower frequency hiss." Chorus or periodic emissions often overlapped emissions of low-frequency hiss. It was found that GP activity sometimes lowers the general level of vlf emission activity. The magneto-conjugacy of GP-associated QP's was also investigated. (UK)

1273 MECHANISM FOR THE AURORAL EMISSION OF O I (6300 A). Mahadevan, P. (Douglas Research Labs., Huntington Beach, Calif.); Roach, F. E. Nature (London), 220: 150-2 (Oct. 12, 1968).

Various mechanisms have been proposed to explain the selectively enhanced emission of OI (6300 Å) from the auroral latitudes of the F-region of the ionosphere. The present communication discusses the enhanced emission in terms of a reaction between the major ion O^+ and the most abundant neutral constituent (O atoms) of the ionosphere at an altitude of ~400 km. It is suggested that the relevant primary particle is the metastable ion $O^+(^2D^0)$. Energy level diagrams and the corresponding emissions for O^+ and O are shown. It is likely that direct excitation by collisions with photoelectrons or fast particles occurs on a large scale, and the ions are de-excited chiefly by collisions with N_2, O_2, and electrons. The proposed reaction is $O^+(^2D^0) + O(^3P_h) \rightarrow O^+(^4S^0) + O(^1D)$ as a prime mechanism for the production of $O(^1D)$. This reaction involves the transfer of electronic excitation energy between ion and atom, as well as electron capture, and it seems reasonable to expect a moderately large cross section for the process, which could well be within the range $10^{-15}\ cm^2 > \sigma > 10^{-17}\ cm^2$. A calculation of the effective cross section for the production of photons by the proposed reaction was made, and a plot is shown of σ_{eff} against fractional abundance of $O^+(^2D^0)$. The radiative efficiency may be much higher than 0.1, since the major quenching agent for $O(^1D)$ is N_2, a rare constituent of the atmosphere at ~400 km. The mechanism could be operative in quiet conditions as well as in the disturbed ionosphere. (UK)

1274 NORTHERN LIGHTS UNVEILED. Hindley, Keith (Liverpool Univ.). New Sci., 40: 74-6(Oct. 10, 1968).

The characteristics and causes of visible auroral phenomena are discussed in the light of satellite studies of the magnetosphere. (UK)

1275 ON ASYMMETRY IN THE F2 LAYER. Gorinov, N. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci., 21: 649-51(1968).

The variations of profiles N(h) with time of the fixed heights were examined in detail by Tomas (1964). During these studies of the period of maximum solar activity a daily asymmetry was noted in the F2 layer because of the fact that at equal zenith

angles of the Sun the electron concentration is higher before noon than after noon. At the same time it was suggested that in years with minimal solar activity at equinox this asymmetry will probably disappear. The distribution of electron concentration was analyzed in order to investigate the asymmetric daily variations with low solar activity. (W.D.M.)

1276 MOTION OF PARTICLES BY ELECTRIC WAVES OF EXTREMELY LOW FREQUENCIES IN THE PRESENCE OF A CONSTANT MAGNETIC FIELD. Schumann, W. O. (Technische Hochschule, Munich). Z. Angew. Phys., 25: 306-8(Oct. 1968). (In German).

The motion of small charged particles caused by extremely low-frequency electromagnetic waves in the presence of a constant foreign magnetic field is studied. The application of the results to the ionosphere of the earth leads to the following conclusions: The excitation of electromagnetic oscillations of the cavity earth–ionosphere (~10 cps) is not only due to flash discharges, it can also be caused by long-wavelength electromagnetic oscillations from outside the ionosphere, e.g., from the Sun. At the same time, extremely fast particles can be brought along with these waves. (auth)

1277 POLAR WIND. Banks, Peter M.; Holzer, Thomas E. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 73: 6846-54(Nov. 1, 1968).

In this letter, calculations, based upon the coupled hydrodynamic equations for the individual ion gases, are presented which indicate the presence of a large-scale upward plasma expansion of the topside polar ionosphere. When ion–neutral gas friction, particle production and loss, gravity, and magnetic-field tube divergence are taken into account, it is found that a transition to supersonic flow velocities takes place. The resulting outward supersonic flow is closely analogous to the solar wind. It is shown that essentially all of the H^+ and He^+ ions created in the polar ionosphere participate in this expansion. (W.D.M.)

1278 POLAR WIND AND THE TERRESTRIAL HELIUM BUDGET. Axford, W. I. (Univ. of California, San Diego, La Jolla). J. Geophys. Res., 73: 6855-9(Nov. 1, 1968).

A problem exists concerning the escape of ^3He and ^4He from the atmosphere. The essential difficulty is that the escape of ^4He cannot be purely thermal, but all nonthermal mechanisms which have been considered to date fail to produce the necessary loss rate by a wide margin. In this letter a new mechanism is suggested which might resolve the problem and which has the interesting implication that it relates the escape of helium to other phenomena, notably the formation of the plasmapause, and the peculiar behavior of the ionosphere at high latitudes. (W.D.M.)

1279 EXPERIMENTAL EVIDENCE OF AN AMPLIFYING MECHANISM IN THE MAGNETOSPHERE. McNeill, F. A. (Dept. of Scientific and Industrial Research, Lower Hutt, New Zealand). J. Geophys. Res., 73: 6860-2(Nov. 1, 1968).

In the course of a study of a frequency shifting mechanism in the magnetosphere, evidence was noted of what appears to be an amplification process for vlf whistler mode radio signals. Some of these signals were observed to exhibit a step-like increase in magnitude of the order of 10 db. This enhancement commonly decays with a time constant of about 50 minutes. (W.D.M.)

1280 ASYMMETRY IN GEOMAGNETIC RESPONSE TO THE POLARITY OF THE INTERPLANETARY MAGNETIC FIELD. Wilcox, John M. (Univ. of California, Berkeley). J. Geophys. Res., 73: 6835-6(Nov. 1, 1968).

Several recent investigations have demonstrated the enhanced geomagnetic effectiveness of a southward component in the interplanetary magnetic field. This raises the possibility of a differing geomagnetic response to interplanetary magnetic field sectors with polarity toward the Sun or away from the Sun. A recent communication [Siebert, 1968] reports that such an effect was indeed observed during the three solar rotations observed by the IMP 1 satellite in the K indices of several geomagnetic observatories in the northern and southern hemispheres. The present analysis confirms and extends these results. (W.D.M.)

1281 CISLUNAR GEOMAGNETIC TAIL GRADIENT IN 1967. Mihalov, J. D.; Sonett, C. P. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 73: 6837-41(Nov. 1, 1968).

The geomagnetic tail field gradients during the summers of 1966 and 1967 were examined for secular change. Data from Ames magnetometers on Explorers 33 and 35 were used. Secular change of the tail field magnitude gradient was not found in the present comparison. (W.D.M.)

1282 ELECTROJET PHENOMENON. Skinner, N. J. (Ahmadu Bello Univ., Zaria, Nigeria). Contemp. Phys., 9: 587-602 (Nov. 1968).

The term "electrojet" is frequently used to describe the intense bands of electric current which flow at certain times in the ionosphere at an altitude of about 100 km. Two main forms of electrojet current are distinguished; an equatorial electrojet which flows during the daylight hours in a narrow band of latitudes centered on the magnetic equator, and an auroral electrojet which flows during the main phase of magnetic storms in auroral regions. Both are accompanied by abnormally large changes in the geomagnetic field components as measured at the Earth's surface. The main features of the two forms of electrojet are reviewed, and the present theories for their origin are discussed. Ionospheric irregularities are associated with both types of electrojet, and the experimental evidence so far accumulated indicates that these are produced by plane plasma waves generated by a two-stream instability in the plasma and traveling with the acoustic velocity of about 360 m s^{-1}. (auth) (UK)

1283 ABSORPTION COEFFICIENTS OF O_2 AT THE LYMAN-ALPHA LINE AND ITS VICINITY. Ogawa, M. (Univ. of Southern California, Los Angeles). J. Geophys. Res., 73: 6759-63(Nov. 1, 1968).

By means of a 3-m vacuum spectrometer, absorption coefficients of O_2 at the Lyman-alpha line and its vicinity were remeasured between 1214.8 and 1217.8 A. Coefficients at the wavelengths of the apparent doublet peaks of the Lyman-alpha line, caused by self-absorption and separated by 0.09 A, are pressure independent at relatively low pressure ($p \leq 6.3$ torr). The absorption coefficient at the shorter wavelength peak is 0.304 ± 0.002 cm^{-1}, and that at the longer wavelength peak is 0.278 ± 0.002 cm^{-1}. The minimum of the transmission window is located at about 1216.0 A, and its value is 0.254 cm^{-1}. (auth)

1284 A STUDY OF DAY–NIGHT VARIATIONS IN THE NEUTRAL COMPOSITION OF THE LOWER THERMOSPHERE. Kasprzak, W. T.; Krankowsky, D.; Nier, Alfred O. (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 73: 6765-82 (Nov. 1, 1968).

Two Aerobee rocket flights were made from the White Sands Missile Range at 0445 MST on November 30, 1966, and at 1409 MST on December 2, 1966, for the purpose of investigating day–night effects in the atmosphere. The number densities of N_2, O_2, O, Ar, and He were determined by using three magnetic deflection mass spectrometers employing "open" and "closed" geometry ion sources. The daytime and nighttime molecular nitrogen, molecular oxygen, and argon densities were found to be very nearly the same. The nighttime atomic oxygen density was a factor of 1.8 higher at 170 km than the daytime value, whereas the helium density was higher during daytime below 200 km; the ratio of the day to night value being 2.5 at 120 km. A comparison of the atomic oxygen density measured in the "closed" and "open" geometries allows an estimate to be made of the wall loss coefficient of both geometries for this species and indicates that the averaged "open" source atomic oxygen densities should be multiplied by about 1.25. Evidence is discussed for the atmosphere being in diffusive equilibrium; the level where the Ar/N_2 separation ratio has a value of 1 is indicated to be near 100 and 102 km for day and night, respectively. (auth)

1285 ANALYSIS AND RESULTS OF LOW-FREQUENCY CW ROCKET PROPAGATION EXPERIMENTS IN THE D REGION. Seliga, T. A. (Pennsylvania State Univ., University Park). J. Geophys. Res., 73: 6783-94(Nov. 1, 1968).

Two low-frequency (163 kHz), continuous-wave rocket propagation experiments were performed at Fort Churchill in the summer of 1963. The analysis and results of these experiments in terms of electron density profiles are presented. The results are compared with those obtained from an ac conductivity probe flown on the same rockets and, in one instance, with Langmuir probe measurements made on another rocket at about the same time during the solar eclipse of July 20, 1963, at Fort Churchill. The analytical techniques used in the propagation experiments are based on a digital-computer full-wave solution of the generalized (includes Sen–Wyller theory) equations governing plane radio-wave propagation in the ionosphere. (auth)

1286 NIGHTTIME IONIC COMPOSITION AND TEMPERATURE OVER ARECIBO. Prasad, S. S. (Cornell Univ., Arecibo, Puerto Rico). J. Geophys. Res., 73: 6795-6807(Nov. 1, 1968).

Results on the composition and temperature of the charged particles in the nighttime topside ionosphere, as obtained from the analysis of incoherent backscatter spectra gathered over the period December 1965 through October 1967 at the Arecibo Ionospheric Observatory are presented. With the growth of solar activity the oxygen-to-light-ion transition altitude went up, the relative abundance of helium ions increased, and the region over which the helium ions occur became thicker. Relative to winter, the oxygen ions were important over a larger altitude range in

summer. In winter nights the oxygen ion concentration began to rise even before the local sunrise. Marked altitude gradient in temperature existed during winter nights. In contrast the whole of the ionosphere under observation was isothermal in summer. (auth)

1287 PLASMA-WAVE INSTABILITIES IN THE IONOSPHERE OVER THE AURORA. Perkins, F. W. (Princeton Univ., N. J.). J. Geophys. Res., 73: 6631-48(Nov. 1, 1968).

Recent observations have disclosed that the ionosphere over the aurora contains considerable fluxes of almost monoenergetic electrons at an energy $E_0 \sim 10$ keV. It is computed that such an energy distribution makes the topside ionosphere unstable to electrostatic plasma waves. The frequencies of these unstable waves are close to the local upper hybrid resonance frequency and the wavelengths λ are given by $\lambda \approx (2E_0/m)^{\frac{1}{2}} (4\nu_c)^{-1} \sim 10$ m. (ν_c is the electron cyclotron frequency.) If the monoenergetic flux equals (or exceeds) a critical value of $\sim 7 \cdot 10^5$ cm^{-2} sec^{-1} ster^{-1} (measured at 90° to the magnetic field), then the plasma waves can grow to an amplitude large enough to cause stochastic acceleration of a few electrons to energies ~40 to 100 keV on a time scale of $\sim 10^{-2}$ sec. The detection of such plasma instabilities is a straightforward radar scatter experiment. (auth)

1288 MAGNETOSPHERIC SUBSTORMS OBSERVED AT THE SYNCHRONOUS ORBIT. Cummings, W. D.; Barfield, J. N.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). J. Geophys. Res., 73: 6687-98(Nov. 1, 1968).

The behavior of the magnetic field at the synchronous orbit during magnetospheric substorms is discussed for several events during December 1966 and January 1967. The vector measurements of the field were made with magnetometers on board the geostationary satellite ATS 1. The field was observed to be depressed and inclined radially outward in the dusk-to-midnight quadrant while substorms were in progress. Similar distortions of the magnetosphere were not observed in other local-time sectors. When the satellite was near local midnight, the onset of the expansive phase of an auroral substorm was coincident with the recovery of the field at ATS 1. When the satellite was further toward the dusk meridian similar recoveries were observed, but they were followed by a renewed depression in the field. An interpretation of the data in terms of partial ring currents in the dusk-to-midnight quadrant is discussed. (auth)

1289 PROPAGATION OF THE SUDDEN COMMENCEMENT OF JULY 8, 1966, TO THE MAGNETOTAIL. Sugiura, M.; Skillman, T. L.; Ledley, B. G.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 73: 6699-6709 (Nov. 1, 1968).

A sudden magnetic field increase associated with the July 8, 1966, sudden commencement (sc) was observed by the OGO 3 satellite in the magnetotail. By use of the IMP 3 and Explorer 33 observations made by Ness and Taylor of the interplanetary shock that caused the sc, it is shown that the magnetospheric propagation of the field increase toward the tail is faster than the propagation of the interplanetary shock just outside the bow shock. Conclusions drawn include (1) that the observed magnetic field increase in the tail is unlikely to be due to an increased lateral pressure of the postshock solar wind gas from the side of the tail, and (2) that the transfer of additional polar magnetic flux to the tail due to the increase in the solar wind pressure on the front side of the magnetosphere can account for the observed tail field increase. (auth)

1290 RING CURRENT PARTICLE DISTRIBUTIONS DERIVED FROM RING CURRENT MAGNETIC FIELD MEASUREMENTS. Hoffman, R. A. (Goddard Space Flight Center, Greenbelt, Md.); Cahill, L. J. Jr. J. Geophys. Res., 73: 6711-22 (Nov. 1, 1968).

The particle energy density distribution for the symmetric portion of the April 17, 1965, magnetic storm was deduced from the measured ring current magnetic field profile. This distribution contains a basic spatial distribution and a time-decay term that is a function of distance in order to accomplish the fit between the calculated magnetic effects of the particles and the measured ring current field over a period of a day. With various assumptions as to the particle loss, the time decay yields the average energy of the particles as a function of distance and thence the total integral omnidirectional proton flux. (auth)

1291 MAGNETOSPHERIC PARAMETERS DETERMINED FROM STRUCTURED MICROPULSATIONS. Kenney, J. F.; Knaflich, H. B.; Liemohn, H. B. (Boeing Scientific Research Labs., Seattle). J. Geophys. Res., 73: 6737-49(Nov. 1, 1968).

The structured elements in Pc 1 and Pi 1 events display dispersion characteristics of multihop and halfhop ulf whistlers, respectively. A large collection of these events was analyzed for different magnetic field and plasma distribution models to obtain information about the source and propagation of these micropulsations as well as information about the magnetospheric plasma distribution. The Pc 1 propagation zone is centered about 75° geomagnetic latitude on the sunlit hemisphere and about 65° on the dark hemisphere. Although equatorial plasma densities are in general agreement with those determined from vlf whistler analysis, some differences exist that may be explained in terms of the generation mechanisms for the different waves. Evidence for steep gradients in the plasma density is presented. The region for propagation of structured Pi 1 elements is located between 6 and 13 R_E at solar magnetospheric longitudes near 135°. The difference between the structured Pc 1 and Pi 1 elements is discussed in terms of hypothetical sources and the magnetospheric wave amplification by trapped particles in the ion-cyclotron resonance interaction. (auth)

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Refer also to abstracts 502, 1552, and 1557.

1292 (COO–1629-10) CRYOGENIC THERMOMETRY: METHODS AND INSTRUMENTATION. Koch, Richard Francis (Illinois Inst. of Tech., Chicago). June 1968. Contract AT-(11-1)-1629. 53p. Dep. CFSTI.

Thesis.

Temperature scales and measurements are reviewed, and specific methods and apparatus constructed and used for thermometry in the liquid helium temperature range at Illinois Institute of Technology are described. Magnetic thermometry, preparation of cerous magnesium nitrate samples for susceptibility measurements, calibration of resistance thermometers, and the mutual inductance bridge are discussed. Circuits for resistance thermometry at liquid helium temperatures are presented, and some results using carbon composition resistance thermometers are reported. (W.H.K.)

1293 A THEORY OF CONDENSED BOSON SYSTEM AND ITS APPLICATION TO THE λ-TRANSITION OF LIQUID HELIUM 4. Lee, Loo-chul. Seattle, Univ. of Washington, 1967. 158p.

Thesis.

The Bogolyubov procedure for the treatment of the condensed boson system is used to generate an approximation scheme which is ultimately applied in the neighborhood of the phase transition line. This procedure, which replaces the creation and annihilation operators $a_0^\dagger$ and a_0 in the original many-body Hamiltonian by the c- number α_0, is the first shown to be mathematically correct in the thermodynamic limit by employing combinatorial analysis and saddle-point techniques. The c-number replacement, which implies the use of the Hamiltonian function $H(\alpha_0)$ in the density matrix, thus does not require the original low-temperature assumptions of Bogolyubov. The determination of α_0 as a function of the temperature and chemical potential is found to be usual one i.e., $\mu = \langle \partial H(\alpha_0)/\partial \alpha_0 \rangle$. The bracket represents the grand canonical average with respect to the density matrix $e^{-\beta(H(\alpha_0)-\mu N')}$. Temperature-dependent Green's functions for the condensed boson system are defined using the density matrix $e^{-\beta(H(\alpha_0)-\mu N')}$. A perturbational approximation scheme for the Green's functions is developed. The Hugenholtz–Pines theorem for finite temperatures has been proved, not from gauge invariance arguments, but from the formal properties of the self-energies. Terms appearing in the second-order self-energies, which are generally neglected in the low-temperature calculations, are found to play an important role in the critical fluctuations near the phase transition. The theory of the λ-transition has been developed based on simple properties of the four-point correlation function $L(1\ 2;1'2') = -\{\langle T(4(1)4(2)4^+(2')4^+(1'))\rangle - \langle T(4(1)4^+(1'))\rangle \langle T(4(2)4^+(2'))\rangle\}$. These properties, which follow from the approximation scheme developed for the self-energies, lead to a particular behavior of the number and energy fluctuations which in turn provide expressions for the important thermodynamic derivatives. The behavior of these derivatives near the transition line, generated ultimately through the approximation for the Green's functions, is found to be identical with that obtained from the Pippard–Buckingham–Fairbank phenomenological description of the λ transition in Helium 4. It is noted that the approximation which yields these results for the phase transition will also give Belyaev's zero temperature results if some of our terms are neglected. These terms are indeed small at T = 0 and would vanish identically if there were no depletion of the zero momentum mode. However, they are very important for the transition region. (Disser. Abstr.)

1294 THICKNESS OF A ROTATING LIQUID HELIUM FILM. Little, Roger Edward. Philadelphia, Univ. of Pennsylvania, 1967. 133p.

Thesis.

The effect of large-film critical velocities on rotation has been investigated by measuring the thickness of a rotating liquid helium film. A variation of Jackson's optical technique is used to measure changes in film thickness directly. The helium film being studied forms on the top of the rotor of a superconducting motor. In contrast to Gribbon and Jackson's moving-film experiment, it is found that these results can be explained using two-fluid hydrodynamics. The thickness of the film is found to be a monotonically decreasing function of both the temperature and the angular velocity. Rotation causes no change in film thickness larger than the experimental error of ±8Å at the low-temperature limit of the cryostat, 1.25°K. These results are compatible with the superfluid component remaining at rest ($V_s = 0$) and the normal component rotating with the moving disk ($V_n = R\omega$). The results are discussed in terms of the possible types of vortices in the film and pinning of vortex lines. It is concluded that the null effect for the superfluid component is a consequence of the nonexistence of vortex lines with their axes perpendicular to the film. The absence of this type of vortex in film flow has been previously discussed by Anderson. (auth)

1295 A MEASUREMENT OF e/h USING THE AC JOSEPHSON EFFECT. Parker, William Henry. Philadelphia, Univ. of Pennsylvania, 1967. 166p.

Thesis.

If two superconductors separated by a sufficiently thin insulating layer are maintained at a potential difference V, an ac supercurrent of frequency $\nu = 2eV/h$ will flow between them. This relation, known as the Josephson frequency–voltage relation, can be shown to be a direct consequence of some quite basic assumptions concerning the macroscopic quantum nature of the superconducting state, and is believed to be an exact relation. A measurement of this frequency and the voltage difference between the two superconductors have yielded a direct determination of the fundamental constant e/h. Measurements were performed on two types of "junctions" which show ac Josephson effect phenomena–evaporated thin film tunnel junctions, and point contact weak links. Determination of e/h to an uncertainty of from 3 to 4 ppM in terms of the electrical units maintained by the National Bureau of Standards was accomplished. During the course of the measurements it was demonstrated that the measured value of e/h was independent of type of superconductor, temperature, frequency, microwave power, step number, magnetic field, geometry, and microscopic process responsible for the Josephson effects. After converting to absolute volts, the final result is $2e/h = 4.835916 \times 10^{14}$ Hz/V ± 6 ppM which differs from the previous best value by 40 ppM. The value of e/h when combined with the measured values of other fundamental constants yields a new value for the fine-structure constant α which differs from the previous accepted value by +20 ppM. This change in α removes the present discrepancy between the theoretical and experimental values of the hyperfine splitting in the ground state of atomic hydrogen, one of the major unsolved problems of quantum electrodynamics. This new value of e/h also leads to new values of the fundamental constants which differ by as much as 100 ppM from the presently accepted values. (Disser. Abstr.)

1296 SUPERCONDUCTING PROPERTIES OF SEMICONDUCTORS. Koonce, Calvin Scott. Berkeley, Calif., Univ. of California, 1967. 200p.

Thesis.

The theory of degenerate many-valley semiconductors developed by Marvin L. Cohen is formulated in a general way to include polar intravalley interactions and screening of intervalley interactions. The kernels appearing in the superconducting gap equation are discussed and the qualitative behavior of the kernels as a function of electron concentration determined analytically. The theory, using the exact kernels, is then applied to $SrTiO_3$, and the superconducting transition temperature is obtained as a function of carrier concentration with the help of a computer. The experimentally determined normal-state properties of $SrTiO_3$ were used with the exception of the intervalley deformation potential which has not been determined experimentally. The value of the intervalley deformation potential is obtained by fitting the experimental superconducting transition temperature at one electron concentration. The complete curve of transition temperature as a function of electron concentration is then obtained and compared with the curve determined experimentally. The agreement is found to be quite good. In order to determine the importance of the approximations made in the calculation of the transition temperature of $SrTiO_3$, a superconducting gap equation for a material having the Fermi energy of the order of or less than the phonon energies was derived. A Green's function method was used to obtain this gap equation so that renormalization effects would be included. This gap equation has an advantage over the gap equation of Cohen in that the kernel is not approximated by the normal state electron–electron interaction. In addition, both the phonon and Coulomb contributions to the renormalization enter in a self-consistent way. (Disser. Abstr.)

1297 SUPERCONDUCTIVITY IN THE PRESENCE OF MAGNETIC EXCHANGE FIELDS. Crow, Jack Emerson. Rochester, N. Y., Univ. of Rochester, 1968. 166p.

Thesis.

The effects of magnetic exchange fields on superconductivity were studied by measuring various properties of systems with dilute concentrations of magnetic impurities. The system chosen for the detailed studies was $InLa_{(3-x)}R_x$ (where R = Ce, Nd, Gd, or Dy). The dependence of T_c on the concentration of magnetic impurities for small concentrations is similar to that observed by other investigators and is consistent with the predictions of the Abrikosov–Gorkov theory. Departures from the theory are observed for higher concentrations which are explained, by Bennemann, as arising from spin ordering effects among the impurity spins. Measurements of the upper critical field as a function of temperature and spin impurity concentrations reveal two distinct regimes of particular interest. In the first, the conduction electrons see an internal exchange field produced by the alignment of the impurity spins in an external field. In this case, a nonmonotonic critical field is observed, which was predicted by de Gennes and Sarma, and the low temperature critical fields are severely depressed from the value for the pure superconductor and from what would be expected for a paramagnetic state of the spins. In the second regime, which is realized for higher impurity concentrations, the impurity spins are self-aligned as a consequence of spin–spin interactions. In this case the critical field curves are no longer nonmonotonic and their concentration dependence suggests the existence of a short range ferromagnetic or "quasi-antiferromagnetic" state. A consistent understanding of the critical field behavior for all spin concentrations is provided by Maki and Fulde's extension of previous theories which consider the problem of the coexistence of superconductivity and ferromagnetism. This extension treats the problem of the simultaneous occurrence of vortices, magnetic exchange fields and depairing effects associated with conduction electron scattering from spin impurities, thus approximating the experimental situation. (Disser. Abstr.)

1298 EFFECT OF PRECIPITATION ON THE CRITICAL CURRENT DENSITY OF Nb–40 AT. PERCENT Zr–10 AT. PERCENT Ti ALLOY IN MAGNETIC FIELD. Doi, Toshio; Ishida, Fumihiko (Hitachi Ltd., Japan). Nippon Kinzoku Gakkaishi, 32: 886-92(Sept. 1968). (In Japanese).

The superconducting properties were examined on Nb–Zr–Ti alloys with an extensive range of composition, and the effect of precipitation on the critical current density J_c of Nb–40 at. % Zr–10 at.% Ti alloy in magnetic field was investigated in relation with the microstructural changes due to the transformation of the β to the β' and β'' phases at 700°C. The main results are as follows: (1) The composition range with high values of J_c was found to expand over the line binding the compositions Nb–47 Zr and Nb–67 Ti in Nb–Zr–Ti alloys. Above all, Nb–40 Zr–10 Ti alloy has the highest J_c below 80 kOe. (2) For Nb–40 Zr–10 Ti alloy aged intermediately at 700°C for 3 hr, the critical field was 105 kOe at 4.2°K; the value of J_c was 3.6×10^5 A/cm² at 40 kOe and 5.0×10^4 A/cm² at 80 kOe; and the critical temperature was 10.3°K. (3) It may be due to the flux-pinning of the β' phase, the weaker superconductor in the β' and β'' phases, that the J_c value of Nb–40 Zr–10 Ti alloy increases by aging at 700°C. (4) The J_c value reaches a maximum value as the size of the β' phase and the spacing between them approach the order of 10 ~ 10² Å. (NSA of Japan)

1299 EFFECT OF PRECIPITATION ON THE CRITICAL CURRENT DENSITY OF Nb–5 AT. PERCENT Zr–60 AT. PERCENT Ti ALLOY IN MAGNETIC FIELD. Ishida, Fumihiko; Doi, Toshio (Hitachi Ltd., Japan). Nippon Kinzoku Gakkaishi, 32: 893-7(Sept. 1968). (In Japanese).

The critical current density J_c vs. applied magnetic field H characteristics was examined on the Nb–Ti side alloys in the Nb–Zr–Ti system, and the effect of precipitation on the J_c vs H characteristics was investigated in relation to the microstructural changes due to the transformation of the β to the α phases at 400 ~ 600°C in Nb–5 at.% Zr–60 at.% Ti alloy. The main results are as follows: (1) The composition with the high J_c at 70 ~ 90 kOe was the Nb–5 Zr–60 Ti alloy. For the Nb–5 Zr–60 Ti alloy aged at 400°C for 100 hr, the value of J_c was 6.4×10^4 A/cm² at 70 kOe and 4.4×10^4 A/cm² at 80 kOe. (2) It may be due to the flux-pinning of the α phase, the normal conductor at 4.2°K in the α and β phases, that the J_c value of Nb–5 Zr–60 Ti alloy increases by aging at 500°C. (3) Flux-pinning by α precipitates was most effective in the early stages of precipitation and the growth of precipitates resulted in reduced values of J_c. (4) The

peak effect of J_c may be due to the interaction between flux lines at high magnetic field near critical field H_{c_2} in the structure with random distribution of pinning strength. (NSA of Japan)

1300 TEMPERATURE EFFECT ON DISSIPATIVE PROCESSES IN TYPE-II SUPERCONDUCTORS. Andronikashvili, E. L.; Tsakadze, Dzh. S.; Chigvinadze, Dzh. G. Soobshch. Akad. Nauk Gruz. SSR, 51: 55-8(July 1968). (In Russian).

In previous studies, the damped oscillations of a disk suspended by an elastic superconducting wire made of the superconducting Ta + 5% Nb alloy were examined. It was found that the behavior of the logarithmic damping decrement is correlated with the increase of internal friction caused by Abrikosov's vortex. The temperature dependence of this phenomenon was further investigated, determining the correlation between the logarithmic decrement of the oscillations and the magnetic field at T = 4.2°K and T = 1.52°K. It was found that lowering of the temperature results in an increase of the maximum; this is probably due to the increase of the Abrikosov vortices with increasing magnetic field, enhancing the dissipation of energy. The studies also revealed that the observed effect is specific for type-II superconductors. The energy of a single vortex was estimated at about 10^{-16} joule, in agreement with literature data. (TTT)

1301 $CuSe_2$, A MARCASITE TYPE SUPERCONDUCTOR. Hull, G. W. (Bell Telephone Labs., Inc., Murray Hill, N. J.); Hulliger, F. Nature (London), 220: 257-8(Oct. 19, 1968).

The various forms of $CuSe_2$ are described, including their structures. Compounds which are metallic because of nonlocalized d electrons are frequently superconductors, and cubic $CuSe_2$(p) has been reported superconducting below ~2.5°K. The high-temperature, high-pressure modifications are more metallic and, if superconducting, they have higher critical temperatures than the corresponding low-temperature modifications. Orthorhombic $CuSe_2$ was examined for superconductivity, and a transition was found at T_c = 0.785°K, well below the critical temperature of the critical temperature of the cubic modification. The transition was very sharp. Measurements were made at 16 kc using an induction method. No superconductivity was observed in cubic $Cu_{1-x}Fe_xSe_2$ with $x \geq 0.25$, although for cubic $Cu_{1-x}Zn_xS_2$, superconductivity persisted up to x = 0.2. (UK)

1302 MICROSCOPIC THEORY OF SUPERCONDUCTIVITY. Taylor, A. W. B. (Univ. of Liverpool). Contemp. Phys., 9: 549-64(Nov. 1968).

A qualitative description of the modern microscopic theory of superconductivity is given, concentrating on the basic physical ideas involved. (auth) (UK)

1303 CRITICAL CURRENTS AND RESISTIVE STATES IN A TYPE-II SUPERCONDUCTOR ($Nb_{0.5}$ $Ta_{0.5}$). Case, William Edward. Nashville, Vanderbilt Univ., 1967. 90p.

Thesis.

Critical-current data and resistive-state measurements are presented for cold-rolled and annealed sheet samples of $Nb_{0.5}$ $Ta_{0.5}$. The Nb–Ta alloy was prepared as a single crystal of high purity prior to cold rolling. The current density J was applied parallel to the rolling direction, and the effects of orientation of an external magnetic field (H_a) relative to J and the defect structures were studied. Microphotographs indicate that a planar fiber structure parallel to the rolling plane (RP) is introduced by cold rolling. Critical currents are lower when planar fibers are oriented parallel to the direction of flux penetration. A field enhancement of the critical current was found for $H_a//J$. The ratio of the maximum longitudinal critical current was 3.5 for the cold-rolled sample and occurred at H/H_{c_2} = 0.7. Annealing reduced the ratio to 1.2 with a broad maximum between H/H_{c_2} = 0.4 and H/H_{c_2} = 0.8. Earlier experiments have explained critical currents by equating the driving force on flux lines to a structure-sensitive, but field-independent, pinning parameter. In this experiment critical currents for $H_a//J$ are correlated with critical currents for $H_a \perp J$, $H_a//RP$ by assuming a field-dependent pinning parameter. Critical current data obtained by varying the angle between H_a and J support this assumption, although an experimental difficulty prevents an accurate determination of the pinning parameter by this method. Resistive-state measurements for the cold-rolled sample for $H_a \perp J$, $H_a \perp RP$, and for the annealed sample for $H_a \perp J$ and $H_a \perp RP$, $H_a//RP$, are in agreement with existing flux-flow theory. The results presented for both types of sample for $H_a//J$, and for $H_a \perp J$, $H_a//RP$ for the cold-rolled sample, are less satisfactory, and limited by local stability problems. (Disser. Abstr.)

1304 SUPERCONDUCTIVE TUNNELING DEVICE CHARACTERISTICS FOR ARRAY APPLICATION. Pritchard, J. Paul Jr.; Schroen, Walter H. (Texas Instruments, Inc., Dallas). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-4: 320-3(Sept. 1968).

Experimental data are presented for superconductive tunneling devices (STD) of varied geometric design. The devices exhibited stable characteristics since they were formed by plasma-induced oxidation of Pb films in conjunction with existent array fabrication technology previously developed for cryotrons. The dependence of the tunneling supercurrent has been measured as a function of barrier perimeter and applied magnetic field. This field is generated by in-line and crossed-film control layers matched to the geometrical dimensions of the barriers. Control of device geometry is shown to yield the unbiased current gain desired for logic and memory applications. The results reported form an empirical basis for arrayed-device design. A cautiously optimistic review of the state-of-the-art in STD technology is included. (auth)

1305 ENTHALPY-STABILIZED SUPERCONDUCTING MAGNETS. Hancox, Roger (United Kingdom Atomic Energy Authority, Abingdon, Eng.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-4: 486-8(Sept. 1968). (CLM-P-163).

An essential requirement for complete stabilization of a superconducting magnet is adequate circulation of liquid helium in the winding, resulting in a low average current density. In partially stabilized magnets, the size of the cooling channels is reduced, but access for liquid helium is still considered necessary. With enthalpy stabilization, however, the need for helium penetration into the winding is eliminated, resulting in better packing of the conductors and a higher average current density. A small enthalpy stabilized magnet has been tested that was fully impregnated with epoxy resin and operated at a current density above $10^4 A/cm^2$. The basis of the design of such magnets is discussed, with particular reference to the choice of conductor size and its effect on average current density in the magnet. Possible applications of this technique are also discussed. (auth)

1306 PERFORMANCE OF STABILIZED SUPERCONDUCTING CABLES UNDER CONTROLLED HEAT TRANSFER CONDITIONS. Gauster, Wilhelm F.; Hendricks, John B. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Magnet., MAG-4: 489-92(Sept. 1968).

Seven different sample types of compound conductors were tested under almost identical conditions for the heat transfer from the cable surfaces to the liquid helium. Three different types of stability were observed: smooth transition from the critical current I_c to a stable flux flow characteristic; an unsteady transition from I_c to a stable flux flow characteristic; and an unsteady transition from I_c to the normal state. Uniform temperature distribution in the compound conductors was tentatively assumed. Furthermore, the heat flux per unit area varied as the 2.5 power of the temperature difference τ between the conductor and helium. This law proved to be valid except for low τ values for which another heat transfer law could be derived from our measurement. For the majority of experiments, the three stability cases could be satisfactorily predicted. Concerning the final transitions to the normal state of the superconductors ("takeoff points"), it was found that the transition from nucleate to film boiling is not always decisive. (auth)

1307 CRITICAL-REGION SECOND-SOUND VELOCITY IN He II. Tyson, J. A.; Douglass, D. H. Jr. (Univ. of Chicago). Phys. Rev. Lett., 21: 1308-10(Oct. 28, 1968).

Data for the velocity and dispersion of second sound in the critical region of He II are presented. To good accuracy, the critical-region expressions relating u_2, ρ_s, and C_p are shown to be self-consistent. The anomalous dispersion is consistent with recent estimates of the coherence length. (auth)

1308 DISPERSION OF PHONONS IN ^{4}He. Eckstein, Shulamith; Varga, B. B. (Argonne National Lab., Ill.). Phys. Rev. Lett., 21: 1311-14(Oct. 28, 1968).

Although the hydrodynamic Hamiltonian is widely used to predict properties of liquid ^{4}He, it has been felt to be inherently unsatisfactory because it was believed that the phonon spectrum at 0°K predicted by this Hamiltonian is $\epsilon = cp$, contrary to experiment. However, a self-energy calculation shows that the predicted spectrum is in fact dispersive, of the form $\epsilon = cp(1-\gamma p^2)$. Lowest-order perturbation theory gives the proper order of magnitude for γ. (auth)

1309 EFFECT OF LATTICE DISORDER ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. Garland, J. W. (Univ. of Illinois, Chicago. Argonne National Lab., Ill.); Bennemann, K. H.; Mueller, F. M. Phys. Rev. Lett., 21: 1315-19 (Oct. 28, 1968).

A theory is presented to explain the dependence of the superconducting transition temperature T_c on the changes in the phonon frequency spectrum and electronic density of states that result from lattice disorder. Numerical calculations of T_c are presented for films composed of crystalline granules, for films composed of

amorphous granules, and for homogeneous amorphous metals. The calculations are in good agreement with experimental values of T_c. (auth)

1310 ENHANCED SUPERCONDUCTIVITY IN LAYERED METALLIC FILMS. Strongin, Myron (Brookhaven National Lab., Upton, N. Y.); Kammerer, O. F.; Crow, J. E.; Parks, R. D.; Douglass, D. H. Jr.; Jensen, M. A. Phys. Rev. Lett., 21: 1320-3(Oct. 28, 1968).

Large increases in the transition temperature T_c of thin, quenched composite films consisting of alternating layers of dissimilar metals were observed. The regions of the film that experience the greatest increase are estimated to be within a few monolayers of the metal–vacuum or metal–metal surfaces. A possible explanation for the increased T_c's is the shift in the electron–phonon coupling to larger values due to the lowering of the phonon frequencies. (auth)

1311 SUPERFLUID PHASE TRANSITIONS IN ONE AND TWO DIMENSIONS. Widom, Allan (Northeastern Univ., Boston). Phys. Rev., 176: 254-7(Dec. 5, 1968).

A recently proved theorem of statistical physics states that a one- or two-dimensional Bose liquid in homogeneous thermodynamic equilibrium cannot undergo Bose–Einstein condensation. The theorem does not apply to inhomogeneous liquids. This is shown by considering the ideal Bose liquid (i) in the presence of a gravitational field and (ii) in rotational motion. The existence of well-defined one- and two-dimensional phase transitions with Bose–Einstein condensation is proved by these explicit examples. (auth)

1312 VELOCITY OF SOUND AT 1 MHz NEAR THE ^{4}He CRITICAL POINT. Williamson, R. C.; Chase, C. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 176: 285-94 (Dec. 5, 1968).

The velocity of 1-MHz sound waves has been measured in ^{4}He along several isotherms just above the critical temperature. The results indicate that along the critical isotherm, the quantity ρ/u^2 diverges approximately logarithmically as a function of $|P-P_c|$. Such a singularity at the critical point is to be expected in view of the corresponding singularity in C_v. Additional velocity measurements were made in the saturated liquid, along isotherms several tenths of a degree above T_c, and along the 4.5 and 5.0°K isotherms in the liquid. The specific-heat ratio has been calculated along the latter two isotherms and along the critical isotherm. (auth)

1313 HELIUM DRAG IN THE THEORY OF IMPURITY MOBILITY IN LIQUID HELIUM. Bailyn, M.; Lobo, R. Northwestern Univ., Evanston, Ill.). Phys. Rev., 176: 222-5(Dec. 5, 1968).

A "helium-drag" effect is calculated for the mobility of charged impurities in ^{3}He, and ^{3}He–^{4}He mixtures. For low-enough temperatures, the momentum imparted by the impurities to the helium may be partly trapped in the impurity-helium system, thereby raising the conductivity. This effect gives rise to a term in the mobility proportional to the concentration of impurities, and varying as T^{-2} for the lowest temperatures. It is estimated that the impurity concentration for this effect to be observed is easily within experimental reach for ^{3}He–^{4}He mixtures, and possibly even for pure ^{3}He. (auth)

1314 CONCENTRATION-DEPENDENT POLARIZATION IN ^{3}He–^{4}He SOLUTIONS. Campbell, L. J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 176: 225-7(Dec. 5, 1968).

The nuclear spin polarization of dilute solutions of ^{3}He in superfluid ^{4}He in contact with a polarized pure ^{3}He bath is calculated for ^{3}He concentrations between zero and 6.37% for various values of the spin relaxation time and transfer rate of ^{3}He into solution. (auth)

1315 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LEAD. Eichler, A.; Wittig, J. (Univ., Karlsruhe, Ger.). Z. Angew. Phys., 25: 319-27(Oct. 1968). (In German).

A high-pressure apparatus has been developed which permits the measurement of the electrical resistance up to pressures of 200 kbar at liquid helium temperatures. Special efforts have been made for the accurate determination of the temperature of the sample above 4.2°K. The pressure dependence of the superconducting transition temperature of lead has been redetermined in order to get a well-defined internal high-pressure manometer for use at low temperatures. (auth)

1316 STABILIZING AND STABILIZING MATERIALS. Van Tilburg, Gerald (American Metal Climax, Inc., New York). Cryog. Eng. News, 3: No. 10, 20-3(Oct. 1968).

The development of large superconducting magnet coils is reviewed. The topics covered are entitled: lower currents in early coils; beneficial perimeter variance; two big superconducting magnets being built; resistivity ratio is merit figure for stabilizers; influence of stress; selecting the stabilizing metal; resistivity ratios; and the effects of resistivity ratio in coils. (M.H.R.)

1317 PRACTICAL ASPECTS OF HOMOPOLAR SUPERCONDUCTING DC GENERATORS. Atherton, David. Cryog. Eng. News, 3: No. 10, 30-6(Oct. 1968).

The theoretical design considerations, practical evolution, practical design, and construction details, operational characteristics and problems, and further possibilities of homopolar superconducting dc generators are summarized. (M.H.R.)

1318 PHASE SEPARATION IN ISOTOPIC FERMI–BOSE MIXTURES. van Leeuwen, J. M. J.; Cohen, E. G. D. (Rockefeller Univ., New York). Phys. Rev., 176: 385-97(Dec. 5, 1968).

An isotopic mixture of fermions and bosons has been investigated at a given pressure, using the hard sphere diameter a as a perturbation parameter. The results agree with those obtained before at a given density. To first order in a it is found that above a critical pressure the mixture separates into two coexisting phases. The phase separation curve has its top on the λ curve of the mixture. The phase separation remains incomplete at T = 0 for a wide range of densities. The slopes at the top and the behavior near T = 0 of the phase separation curve have been computed. Also, the osmotic pressure of dilute solutions has been obtained. (auth)

1319 SUPERFLUID FRACTION OF LIQUID HELIUM CONTAINED IN POROUS VYCOR GLASS. Fraser, J. C.; Rudnick, I. (Univ. of California, Los Angeles). Phys. Rev., 176: 421-2 (Dec. 5, 1968).

Using fourth sound, there have been recent determinations of the superfluid fraction in helium contained in pores small enough that size effects modify the superfluid state. The results reported for porous Vycor glass, which is presumed to have a random cylindrical capillary system, are sufficiently different, in several respects, from those reported for packed granular powders that the question arises whether there is an inherent difference in the effect of the two kinds of porous geometries. The purpose of this note is to report the results of some measurements on Vycor (Corning porous glass 7930) which do not show these differences. (M.O.W.)

1320 SUPERCONDUCTIVITY OF Cu–Sb PHASES AND ABSENCE OF ANTIFERROMAGNETISM IN Cu_2Sb. Andres, K.; Bucher, E.; Maita, J. P.; Cooper, A. S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett., 28A: 67-8(Oct. 21, 1968).

Superconductivity, low-temperature specific heat, and magnetic susceptibility are reported for all Cu–Sb phases. No evidence of antiferromagnetism in Cu_2Sb was found, contrary to an earlier study. (auth)

1321 THEORY OF THE NUCLEAR SPIN RELAXATION RATE IN TYPE-II SUPERCONDUCTORS NEAR THE UPPER CRITICAL FIELD. Pesch, W. (Univ., Hamburg). Phys. Lett., 28A: 71-2(Oct. 21, 1968).

The relaxation rate in the mixed state, R_S, was calculated for magnetic inductions B near H_{c2} and for all mean free paths l of the electrons. The present theory is in good agreement with recent measurements on vanadium. (auth)

1322 RESISTIVE TRANSITION TAILING IN AN ARRAY OF JOSEPHSON JUNCTIONS. Clark, T. D. (Mullard Research Labs., Surrey, Eng.); Tilley, D. R. Phys. Lett., 28A: 62-3 (Oct. 21, 1968).

The resistive transitions of arrays of tin spheres have a low-temperature tail determined by phase slippage at the contact points. (auth)

1323 CALORIMETRIC INVESTIGATION OF TYPE-II SUPERCONDUCTORS. Zoller, Paul. Madison, Wis., Univ. of Wisconsin, 1968. 67p.

Thesis.

The specific heat at constant applied magnetic field as a function of temperature between 1.5° and 4.2°K was measured for spherical samples of In–Pb alloys. These alloys were type-II superconductors. The predictions of the Ginzburg–Landau–Abrikosov theory and its extension to lower temperatures were transformed into predictions about the behavior of the specific heat. The influence of a nonzero demagnetizing factor on the magnetization curve and on the thermodynamic properties of ellipsoidal superconductors are presented in some detail. The experimental results are used for a discussion on the effect of irreversibility on the determination of Maki's parameters K_1 and K_2 in magnetization and specific-heat measurements. Evidence is presented to show that K_1 can be determined reliably from specific-heat measurements even in the presence of severe irreversibility. The temperature and mean-free-path dependence of K_1 obtained from these measurements is in very poor agreement with existing theories: The temperature dependence is

stronger than the theoretical models predict, while the mean-free-path dependence is opposite to that required by theories. Two appendices give experimental details. (Diss. Abstr.)

1324 ULTRATHIN FILM TUNNEL JUNCTIONS. Wilson, J. P. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 28A: 43-4(Oct. 21, 1968).

Current–voltage characteristics of $Al/Al_2O_3/Bi$ tunnel junctions were obtained for extremely thin Bi films by recording the characteristics as the film was condensed. The energy gap in Bi was shown to decrease with thickness below 40 Å. (auth)

1325 ENHANCEMENT OF SUPERCONDUCTIVITY BY SEMIMETALLIC (OR SEMICONDUCTING) INCLUSIONS. Meunier, F.; Hauser, J. J.; Burger, J. P.; Guyon, E.; Hesse, M. (Laboratoire de Physique des Solides, Orsay, France). Phys. Lett., 28A: 37-8(Oct. 21, 1968).

Critical temperature results are given on superconductor and semi-metal or semiconductor mixtures. The values observed are high (up to 6.45°K for Al + 10% Ge). (auth)

1326 DYNAMIC CRITICAL FLUCTUATION IN SUPERCONDUCTORS ABOVE THE TRANSITION POINT. Tsuzuki, T.; Kawasaki, K. (Kyushu Univ., Fukuoka). Phys. Lett., 28A: 40-1 (Oct. 21, 1968).

The correlation function of the fluctuation field in a dirty superconductor is investigated. The diffusion constant in the critical region becomes singular as $(T/T_c - 1)^{-\frac{1}{2}}$. The electrical conductivity contains a term increasing like $(T/T_c - 1)^{-\frac{1}{2}}$ in the critical region. (auth)

1327 DYNAMICAL CRITICAL PHENOMENA IN LIQUID HELIUM. Kawasaki, K.; Tsuzuki, T. (Kyushu Univ., Fukuoka). Phys. Lett., 28A: 30-1(Oct. 21, 1968).

A dynamical aspect of critical phenomena at the λ transition of liquid helium is considered employing the general theory of dynamics of critical fluctuations. (auth)

1328 DYNAMICAL CRITICAL PHENOMENA IN SUPERCONDUCTIVITY. Kawasaki, K.; Tsuzuki, T. (Kyushu Univ., Fukuoka). Phys. Lett., 28A: 29(Oct. 21, 1968).

Critical phenomena in superconductivity are studied employing the authors' general theory of dynamics of critical fluctuations. (auth)

1329 ORDER PARAMETER FOR SUPERFLUID HELIUM. Frankel, N. E. (Univ. of Melbourne). Phys. Lett., 28A: 7-8 (Oct. 21, 1968).

An equation is presented which accurately predicts the temperature dependence of ρ_s, the superfluid density for the entire temperature interval $1.2°K \leq T \leq T_\lambda$. A physical model of the superfluid which provides a motivation for this equation is also presented. (auth)

1330 ANOMALOUS BEHAVIOR OF THE SUPERCONDUCTING TRANSITION TEMPERATURE IN $La_{3-x}Gd_xAl$. Yasukochi, K.; Kuwasawa, Y.; Sekizawa, K. (Nihon Univ., Tokyo). Phys. Lett., 28A: 12-13(Oct. 21, 1968).

The dependence of the superconducting transition temperature on the concentration of Gd spins was investigated for the $La_{3-x}Gd_xAl$ system. A departure of the experimental curve from the theoretical curve of Abrikosov–Gor'kov was observed at high impurity concentrations. (auth)

1331 FLUX PENETRATION OF A HARD SUPERCONDUCTING TUBE. Wischmeyer, C. R. (Rice Univ., Houston, Tex.). Phys. Lett., 28A: 14-15(Oct. 21, 1968).

Observed flux jumps correlate with sharply increased Joulean dissipation when a flux front penetrates the bore of a Nb–Zr tube. Varying the wall thickness exhibits a maximum of dissipation. (auth)

1332 SOFT SURFACES AND A SIZE EFFECT IN SUPERCONDUCTIVITY. Gamble, F. R.; Shimshick, E. J. (Stauffer Lab. for Physical Chemistry, Stanford, Calif.). Phys. Lett., 28A: 25-6(Oct. 21, 1968).

The enhanced critical temperatures of thin or granular non-transition-metal superconductors are rationalized in terms of recent theoretical work. (auth)

1333 THEORY OF ANOMALOUS SUPERCONDUCTORS. Medvedev, Yu. V. (Moscow State Correspondence Teacher's Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 137-40(1968). (In Russian).

The properties of Pb, Hg, Nb, and other anomalous superconductors cannot be described by the ordinary theory developed on the basis of weak bonds. In the anomalous superconductors the electron-photon interactions are not weak and cannot be reduced to the four-fermion concept. Therefore, properties of such superconductors were studied using the Froelich-model Hamiltonian which describes electron interactions with the lattice. In contrast to ordinary superconductors the ratio T_c/θ (T_c is the critical temperature and θ is the Debye temperature) for anomalous superconductors is not negligibly small. Previously it was shown that the energy gap in anomalous superconductors is determined by the phonon dispersion law $\omega(g)$. An attempt is made here to determine the energy gap behavior and thermodynamic properties of superconductors for the case in which the function $\omega(g)$ represents an ordinary sound ($\omega(g) = \omega g$)). (R.V.J.)

1334 SUPERCONDUCTING PROPERTIES OF METALLIC INDIUM ANTIMONIDE. Dorer, Gary Lee. Los Angeles, Univ. of California, 1968. 96p.

Thesis.

Single crystals of metallic indium antimonide (InSb II) were grown under a pressure of 26 kbars and recovered at liquid nitrogen temperatures. X-ray Laue studies were made on these crystals to verify that they were indeed single. The magnetic properties of the superconducting state of InSb II were studied by making torque, magnetization, and resistance studies on these single crystals. It has been determined from the above studies that InSb II is a type-II superconductor with an anisotropic upper critical field. The anisotropy in H_{c2} has been found to be approximately 50% at T = 1.2°K, ranging from 36 gauss for fields parallel to the tetragonal axis, to 60 gauss for fields perpendicular to the [001] axis. This anisotropy decreased to zero at T_c, which has been found to be in the neighborhood of 1.58°K. The above results were interpreted in terms of the Ginzburg–Landau theory for anisotropic superconductors. The agreement was found to be quite good if the effective mass tensor were assumed to have an anisotropy of approximately 95%. The Ginzburg–Landau κ parameter at T = 1.20°K has been estimated to range from ~0.8 for fields along the tetragonal axis to ~1.25 for fields perpendicular to the tetragonal axis. Assuming a parabolic relationship for $H_c(T)$, the zero temperature critical field H_0 has been estimated to be ~80 gauss and the electronic specific heat coefficient for normal electrons to be ~400 ergs/cm³°K². When these results are compared to those of white tin, it is apparent that the electronic structure of InSb II is quite different from that of white tin, even though their density, average ionic mass, and number of electrons/cm³ are identical. (Disser. Abstr.)

1335 SOME ENGINEERING LIMITATIONS OF SUPERCONDUCTORS IN POWER TRANSFORMERS, POWER CABLES, AND MACHINES. Wilkinson, K. J. R. (Associated Electrical Industries Ltd., Rugby, Eng.). Nature (London), 219: 1317-19(Sept. 28, 1968).

The use of superconductors for handling electrical power is still limited by the refrigeration involved and problems associated with high magnetic fields at the conductor. Copper, therefore, still holds its advantage. (auth)

1336 PROBLEMS OF THE QUANTUM THEORY OF LIQUID HELIUM. Davison, Tollie Bowers. St. Louis, Washington Univ., 1968. 151p.

Thesis.

Three main problems are considered. The first concerns the Feynman wave function for a single excitation in liquid ^{4}He. The second deals with dilute solutions of ^{3}He in ^{4}He at low temperature. The third and final problem examines the contribution of three-phonon interactions to the ground-state energy of liquid ^{4}He. In the first problem an approximate trial function $\psi_k^\dagger$ representing a one-phonon state is tested by evaluating the variance of H, $\overline{(H-\bar{H})^2}$, the bars denoting expectation values with respect to the assumed trial function. Two procedures for estimating $\overline{(H-\bar{H})^2}$ are developed and found in one case to depend on the asymptotic behavior of the trial function and in the other to involve the three-particle distribution in a sensitive manner. Tentative results are correlated with the analysis of the free phonon state by Pines, Miller, and Nozières and by Huang and Klein. An approximate analytic expression for the ground-state correlation function is examined, and the agreement one gets with more elaborate calculations is noted. The second problem starts with a second-order perturbation calculation of the energy of an impurity atom (fermion) in a uniformly extended system of bosons. The results are used to calculate some of the properties of dilute solutions of ^{3}He in ^{4}He at low temperatures. Calculations are made on the binding energies, effective masses, and the effective interaction among ^{3}He atoms in the solutions. The results are compared with experiment and the calculations of Bardeen, Baym, and Pines. The last problem gives an estimate of the contribution of the three-phonon vertex to the ground-state energy of liquid ^{4}He. Starting with a close approximation to the optimum Jastrow wave function describing the ground state, second order perturbation theory

is used to find the three-phonon contribution to the energy. The energy correction is fairly large (in the neighborhood of 1°K/atom) and depends strongly on the density. (Disser. Abstr.)

1337 NONLINEAR MICROWAVE EFFECTS IN SUPERCONDUCTING FILMS. Chou, Su-min. Salt Lake City, Utah, Univ. of Utah, 1968. 127p.

Thesis.

The basic wave-propagation problem in a rectangular wave guide with a thin conducting film placed across it has been solved. The microwave transmission and reflection are simple functions of film resistance and frequency. The experimental measurements and theoretical prediction give reasonable agreement. As the thin film is in a superconducting state, the conductivity of the film is a function of the applied magnetic field. A Taylor's series expansion for conductivity σ involving the derivatives of σ with respect to the magnetic field H has been used to study the microwave nonlinear effects, especially for the harmonic generation. A rather complicated wave equation has been solved with the help of simplifying approximations to find the possible generated modes and power of harmonic signal. These calculations show that for a very thin film (less than one hundred angstroms) the generated harmonic signals in both the transmitted and the reflected wave are equal. Pure tin was used for such experimental investigation at 9.075 GHz. The results are in close qualitative correspondence to the theoretical predictions, and a basic understanding of the nonlinear electrodynamics that will lead to the further study of microwave nonlinear effects of superconductors has been obtained. (Diss. Abstr.)

1338 ULTRASONIC ATTENUATION IN THE SUPERCONDUCTING STATE OF HIGH-PURITY THALLIUM. Willard, H. J. Jr.; Shaw, R. W.; Salinger, G. L. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 175: 362-7(Nov. 10, 1968).

The electronic attenuation of longitudinal ultrasonic waves (10 to 130 MHz) was measured in the superconducting state of high-purity thallium by the pulse echo technique. α_s/α_n, the ratio of superconducting- to normal-state attenuation, decreased faster with decreasing T/T_c in the temperature region just below the transition temperature T_c than predicted by the BCS theory. The zero-temperature energy gaps, based on the low-temperature data, were $(3.90 \pm 0.1)kT_c$, $(3.52 \pm 0.15)kT_c$, and $(3.70 \pm 0.20)kT_c$ for propagation along the [0001], [$\bar{1}2\bar{1}0$], and [$10\bar{1}0$] directions, respectively. No frequency effects were observed in α_s/α_n versus T/T_c for propagation along the [0001] and [$\bar{1}2\bar{1}0$] directions. For q || [$10\bar{1}0$], however, α_s/α_n varied with frequency, dropping faster as T was lowered below T_c and as the frequency became lower. The attenuation was found to be amplitude-independent in the superconducting and normal states. (auth)

1339 ULTRASONIC DETERMINATION OF THE PRESSURE DEPENDENCE OF THE SUPERCONDUCTING ENERGY GAP IN TIN. Beattie, A. G. (Sandia Corp., Albuquerque, N. Mex.); Schirber, J. E.; Neighbours, J. R. Phys. Rev., 175: 599-603 (Nov. 10, 1968).

The effect of hydrostatic pressures to 3.3 kbar on the superconducting energy gaps in Sn is determined by measuring the longitudinal ultrasonic attenuation for propagation along [110], [100], and [001] directions. The extreme weak-coupling-limit prediction of the BCS theory that the volume dependence of the energy gap at absolute zero is equal to the volume dependence of the transition temperature is experimentally verified for Sn. (auth)

1340 ULTRASONIC INVESTIGATION OF THE ISOLATED-VORTEX STATE NEAR H_{c1} IN VANADIUM. Sinclair, A. C. E.; Leibowitz, J. R. (Univ. of Maryland, College Park). Phys. Rev., 175: 596-9(Nov. 10, 1968).

Ultrasonic attenuation in the mixed state of vanadium has been investigated near H_{c1}, where the vortex density is low. The expected rise toward the normal-state value of attenuation at H_{c2} is preceded by an initial absorption decrease as the vortices penetrate. The unexpected dip is interpreted in terms of a reduction in the quasiparticle mean free path, a result of the scattering of quasiparticles by vortices. The scattering width of a vortex was found to be $(2.4 \pm 0.4) \times 10^{-6}$ cm for temperatures near T_c, in good agreement with the theoretical determination 2.1×10^{-6} cm. The apparent width decreases at lower temperatures. Similar measurements have been made in niobium. The scattering width is found to be considerably greater in vanadium, and its temperature dependence is in the opposite direction. A further feature of the present results observed even at rather low fields was the faster-than-linear dependence of the reciprocal attenuation on the internal field. (auth)

1341 SCATTERING OF SINGLE-PARTICLE EXCITATIONS BY A VORTEX IN A CLEAR TYPE-II SUPERCONDUCTOR. Cleary, Robert M. (Stanford Univ., Calif.). Phys. Rev., 175: 587-96(Nov. 10, 1968).

A study of the scattering of BCS single-particle excitations by an isolated vortex in a clean type-II superconductor is reported. The coupled Bogoliubov equations provide a theoretical framework for calculating quasiparticle wave functions. The vortex introduces superfluid velocity into the metal, depresses the order parameter $\Delta(r)$ at the core, and gives rise to a Bohm–Aharonov effect. The scattering problem has two channels with coupling between particlelike and holelike excitations. The total cross section diverges because of the Bohm–Aharonov effect, but the cross section σ_1 for a particle to scatter from one channel to the other remains finite. This quantity σ_1 is also equal to one-half the transport cross section. A numerical evaluation of σ_1 as a function of the energy and polar angle of the excitations relative to the external field has been made. (auth)

1342 DC JOSEPHSON EFFECT FOR STRONG-COUPLING SUPERCONDUCTORS. Fulton, T. A.; McCumber, D. E. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 175: 585-6 (Nov. 10, 1968).

The maximum zero-voltage (Josephson) current I_s in identical-superconductor tunnel junctions is shown to be related to the response of the bulk superconductor to ac fields. Strong-coupling effects reduce I_s to 78.8% of the weak-coupling prediction for Pb and to 91.1% of that for Sn, corresponding to similar strong-coupling reductions in the bulk supercurrent response of these materials. (auth)

1343 ANOMALOUS ELECTRICAL CONDUCTIVITY ABOVE THE SUPERCONDUCTING TRANSITION. Kadanoff, Leo P.; Laramore, George (Univ. of Illinois, Urbana). Phys. Rev., 175: 579-84(Nov. 10, 1968).

The rise in the electrical conductivity as a material approaches its superconducting transition is described in terms of fluctuation theory. About T_c, small regions become superconducting and can carry an anomalous current, thereby causing a rise in conductivity. The use of the Kubo formula permits the estimation of the contribution from this source. A comparison of this estimate with previous theories and experiment is carried out. (auth)

1344 MAGNETIC FLUX PENETRATION IN TYPE-II SUPERCONDUCTORS. I. del Castillo, G. (Argonne National Lab., Ill.); Fast, R. W. Phys. Rev., 175: 575-8(Nov. 10, 1968).

Five magnetoresistance probes were used for mapping the magnetic field between matched pairs of superconducting plates oriented normal to an external magnetic field. All plates were 25 × 25 mm and their thicknesses varied from 0.23 to 0.79 mm. The separation between plates was 4.7 mm. In Nb–Zr and Lipowitz-alloy plates, the field penetrated smoothly into the material; the mappings obtained at different external-field values consisted in symmetric contours conforming with the geometry of the plates. In Nb_3Sn and Nb–Ti, only flux jumps were observed; the magnetic contours were very irregular and randomly distributed after each flux jump. Using the five-probe arrangement, a study was made of the frequency and extension of the magnetic-field change during a flux jump. In this case, the external magnetic field varied at the constant rate $dH/dt = 5.6$ G/sec within H = 0 to 2500 G. Only Nb_3Sn plates were studied. A statistical analysis of the results demonstrated that at 4.2°K only extensive jumps occurred in virgin samples for positive values of dH/dt. A distribution with a "tail," consisting of local jumps, was obtained after dH/dt changed sign and in all successive nonvirgin runs. At 1.5°K all distributions had the tail regardless of magnetic history and the sign of dH/dt. It is concluded that, as far as flux jumps are concerned, the reversal in the sign of dH/dt produced (in the superconductor at 4.2°K) a state which made it more susceptible to flux jumps. A state with similar susceptibility is obtained at 1.5°K — in this case, it is presumably originated by thermal effects. (auth)

1345 EXPERIMENTAL TEST OF THE THEORY OF THE PROXIMITY EFFECT IN SUPERCONDUCTORS. Jacobs, A. E.; Ginsberg, D. M. (Univ. of Illinois, Urbana). Phys. Rev., 175: 569-75(Nov. 10, 1968).

The transition temperatures of superimposed films of indium and thallium were measured to test the theory of the proximity effect. There is good agreement between the experimental results and the theory. The transition temperatures of superimposed films of lead and indium were also measured, for which strong electron-phonon coupling might invalidate the theory. The agreement with theory is again good, as found by other investigators. (auth)

1346 THEORY OF SUPERCONDUCTOR–NORMAL-METAL INTERFACES. McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J. Cambridge Univ., Eng.). Phys. Rev., 175: 559-68(Nov. 10, 1968).

The superconducting properties of the clean superconductor–normal-metal interface are calculated assuming a constant BCS potential $\Delta(x)$ in the superconductor and zero potential in the normal metal. The local electronic density of states, which is measured in the tunneling experiments, is evaluated and the mag-

nitude of the interference-effect oscillations found. The BCS potential is recalculated and is believed to be nearly self-consistent. The pair amplitude $\langle\psi^+(x)\psi^+(x)\rangle$ and the potential oscillate $\alpha \cos(x/\xi)$ in the normal metal. A Josephson tunneling experiment to measure the pair amplitude is suggested. (auth)

1347 CALCULATION OF THE EFFECT OF SUPERCONDUCTING ENERGY-GAP ANISOTROPY ON THE THERMAL CONDUCTIVITY OF TIN. Burckbuchler, F. V.; Markowitz, D.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., 175: 556-9(Nov. 10, 1968).

With an interpretation of recent experimental data on electrical resistivity and on superconducting energy-gap anisotropy in tin, the anisotropy in pure tin of the superconducting-state electronic thermal conductivity K_e^s relative to the normal-state conductivity K_e^n was calculated. The effect of doping on K_e^s/K_e^n was also calculated. The calculation is based on the work of Ulbrich et al., but replaces their continuously varying gap function with one which is constant over limited sectors in momentum space in accordance with tunneling data, and which weighs the gap effectiveness with the anisotropic electron mean free path. Good quantitative agreement is found with the existing experimental data. (auth)

1348 EFFECT OF ANTIMONY, INDIUM, AND ZINC IMPURITIES ON THE CRITICAL-FIELD CURVE OF TIN. Burckbuchler, F. V.; Markowitz, D.; Reynolds, C. A. (Univ. of Connecticut, Storrs). Phys. Rev., 175: 543-50(Nov. 10, 1968).

Measurements have been made of the superconducting critical field and the residual resistivity of oriented single-crystal tin samples containing In, Sb, and Zn impurities up to 2.2 at. %. The theory of Markowitz and Kadanoff is found to describe the variation of transition temperature with resistivity reasonably well. From the comparison, a value of 0.020 is obtained for the mean squared anisotropy of the superconducting energy gap in tin. Linear variations of ΔT_c, ascribable to impurity-induced variations of the gross parameters of the superconducting system, are determined to be 141, 135, and 58 m°K/$\mu\Omega$ cm for Zn, Sb, and In impurities, respectively. These results are in good agreement with previous measurements on polycrystalline material. It is found that the impurity-induced variation of the critical-field parameters, H_0/T_c and $(dH_c/dT)_{T_c}$, is in accord with Clem's theoretical calculations based on the washing out of gap anisotropy by impurity scattering. Comparison of the data with this theory suggests that the average density of states at the Fermi surface in tin is not seriously altered by the addition of up to 2 at. % impurity. Linear variations of ΔH_0 with $\rho_{0\perp}$ are found to be similar to those of ΔT_c. These linear variations of ΔH_0 and ΔT_c are correlated in a way predicted by BCS. (auth)

1349 TUNNELING MODEL OF THE SUPERCONDUCTING PROXIMITY EFFECT. McMillan, W. L. (Bell Telephone Labs., Murray Hill, N. J. Cambridge Univ., Eng.). Phys. Rev., 175: 537-42(Nov. 10, 1968).

A study is made of a simple theoretical model of the proximity effect between superposed normal and superconducting metal films. A potential barrier between the films is imagined and electron transmission through the barrier is treated as a tunneling process. For thin films the model is soluble, and the BCS potential can be treated self-consistently and the excitation spectrum calculated. The transition temperature, the energy gap, and the electronic density of states are computed for comparison with tunneling experiments. (auth)

1350 LOW-TEMPERATURE MOBILITY OF HEAVY IMPURITIES IN FERMI LIQUIDS. Gould, Harvey (Univ. of Michigan, Ann Arbor); Ma, Shang-keng. Phys. Rev. Lett., 21: 1379-82(Nov. 4, 196).

The temperature dependence of the mobility μ of a heavy impurity in an interacting Fermi liquid is found to be of the form $1/\mu = A + BT^2 \ln(1/T) + O(T^2)$ for low T. The coefficients are calculated for the case of a large, hard-sphere impurity. The result is in qualitative agreement with recent experimental data for negative ions in ^{3}He. (auth)

1351 SUPERCONDUCTIVITY OF $Nb_3(Al,Ge)$ ABOVE 20.5°K. Arrhenius, G.; Corenzwit, E.; Fitzgerald, R.; Hull, G. W. Jr.; Luo, H. L.; Matthias, B. T.; Zachariasen, W. H. (Univ. of California, San Diego, La Jolla). Proc. Nat. Acad. Sci. U. S., 61: 621-8(Oct. 1968).

On the basis of the present analysis, combined with the empiricism of composition and annealing, it is now possible to approach 21°K. The essential reasons for this are a favorable electron concentration and a nearly perfect β-W stoichiometry, which is coupled with an improved degree of order. There is no doubt that these parameters can be further optimized and, therefore, that still higher transition temperatures exceeding 22°K will be obtainable in the Nb-Al-Ge system. (auth)

1352 INFLUENCE OF THE STRUCTURE ON THE SUPERCONDUCTIVITY OF NbTi 50 AND NbTi 65. Pfeiffer, I.; Hillmann, H. (Laboratorium der Vacuumschmelze GmbH, Hanau, Ger.). Acta Met., 16: 1429-39(Dec. 1968). (In German).

The correlation between the structure and the superconducting behavior of niobium-titanium alloys has been established by electron microscopy and $I_c(H)$ measurements. It is shown that the substructures produced by heavy cold work are an essential prerequisite for obtaining the high field properties of these type-III superconductors. On the one hand, the subgrain boundaries as quasi-directed dislocation arrangement which act as pinning centers, on the other hand, during a heat treatment they make the formation of additional disturbance centers possible, acting as nuclei for the precipitation of the hexagonal α-phase in a size and concentration which is suitable for the pinning mechanism. The $I_c(H)$ values, obtained by cold work and heat treatment—that is production of substructures and α-precipitation—can even be increased by an additional deformation after the heat treatment. The cause of this increase is finer precipitates as well as the elimination of the substructure recovery which has occurred during the heat treatment. Furthermore the influence of the martensite formation on the $I_c(H)$ behavior is investigated and it is shown that the ω phase appears. (auth)

1353 PHONON SPECTRUM CHANGES IN SMALL PARTICLES AND THEIR IMPLICATIONS FOR SUPERCONDUCTIVITY. Dickey, J. M. (Brookhaven National Lab., Upton, N. Y.); Paskin, Arthur. Phys. Rev. Lett., 21: 1441-3(Nov. 11, 1968).

Molecular-dynamic techniques were used on bulk crystals and particles several atom-layers thick to study phonon behavior. It is found that the surface modes in the small particles produce changes in the phonon spectrum quantitatively large enough to explain the observation by Strongin and co-workers of large increases in the superconducting transition temperature of extremely thin films. (auth)

Plasma and Thermonuclear Physics

1354 (AED-C-03-23) PLASMA PHYSICS INDEX. EXPERIMENTAL AND THEORETICAL PLASMA PHYSICS. Vol. 3, No. 8. Hilsenbeck, D. (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). 1968. 168p. Dep.

A listing is presented of 460 articles on various aspects of plasma physics. Complete subject and author indexes are included. (M.O.W.)

Confinement and Heating

1355 (IPPJ-70) PRESSURE DEPENDENCE OF A PLASMA DIFFUSION ACROSS A UNIFORM MAGNETIC FIELD. Uramoto, Johshin (Nagoya Univ. (Japan). Inst. of Plasma Physics). May 1968. 22p. Dep.

By controlling only a neutral gas pressure, diffusion modes of a plasma across a uniform magnetic field B are varied independently of boundary wall conductivity. That is, the diffusion up to $B = 10^3$G is of a classical ambipolar diffusion near a helium gas pressure of 10^{-1} mm Hg, of a Bohm type diffusion near 10^{-2} mm Hg, and of a classical ion free diffusion near 10^{-3} mm Hg. The plasma is produced by continuous injection from a modified duoplasmatron, whose length is 34 cm along B. With a decrease of the pressure, random noise potentials in the plasma increase up to the electron temperature. Thus, the electron diffusion, in the plasma near 10^{-3} mm Hg where Simon effect may be observed, is enhanced greatly compared with the classical diffusion. As a result, the ambipolar field is much reduced so that the effect is not ensured. (auth)

1356 (JINR-P9-4044) STOCHASTIC HEATING OF PLASMA PARTICLES. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 18p. (In Russian). Dep.

The theory of stochastic heating is derived, with stochastic electromagnetic field correlation effects are taken into account. (auth)

1357 (LA-3990, pp A5.1-8) NUMERICAL STUDY OF CHARGED PARTICLE HEATING BY PLASMA TURBULENCE. Gary, S. Peter; Montgomery, David (Iowa Univ., Iowa City. Dept. of Physics and Astronomy).

Numerical calculations were made of the heating of charged particles by turbulent electric fields. The fields are given, and are not required to be self-consistently supported by the particles. Three types of wave spectra are treated, each of which is analytically unmanageable: (1) many waves, constant phases and velocities; (2) one wave, randomly interrupted phase; (3) one wave,

slowly varying wave number at constant frequency. Large particle energization is found in the last two cases. In all three cases, the results can be qualitatively understood by elementary arguments related to particle "trapping." (auth)

1358 (LA-3990, pp C8.1-3) EARLY RESULTS FROM A TWO-DIMENSIONAL DRIFT EQUATION SIMULATION. De Young, David S. (Los Alamos Scientific Lab., N. Mex.).

Some early results of a two-dimensional axisymmetric plasma simulation code are presented, in particular the end loss from a high-beta theta pinch and the simulation of astronomical objects. A brief discussion of the code, which employs the first-order drift equations and invariant magnetic moments, is given. (auth)

1359 (LA-3990, pp D4.1-5) FLUID DESCRIPTION FOR TOROIDAL LOW β CONFINEMENT. Johnson, John L.; Winsor, Niels K.; Dawson, John M. (Princeton Univ., N. J. Plasma Physics Lab.).

A computer program is being developed to study the confinement of low-β plasmas in simple axially symmetric configurations from the fluid point of view. The equations contain the effects of resistivity, plasma inertia, the Hall term, and pressure gradients along the magnetic field lines, and will be generalized to include viscous and gyroviscous effects (general stress tensor). The calculations will complement the self-consistent calculations of Smith and Bishop as well as supplement them by including collisional effects. They should lead to a better understanding of the effects of mass flow (streaming along the field lines and rotation about the toroidal axis) on plasma losses due to classical diffusion. The model should indicate how well an ideal model approximates the behavior of a real plasma. At present Knorr's model for an ideal stellarator is being employed. It will be extended to represent spherators or multipoles. Results to date include good agreement with a similarity solution for classical diffusion in a cylinder and with the Pfirsch–Schlüter factor in a torus without flow and the observation and recognition of a modification of sound waves when the curvature of the magnetic field lines has a component in the plane of the magnetic surfaces. (auth)

1360 (LA-3990, pp D5.1-5) VELOCITY-SPACE EFFECTS IN THE COMPUTER SIMULATION OF STELLARATOR CONFINEMENT. Smith, Craig G. (Princeton Univ., N. J. Plasma Physics Lab.); Bishop, A. S. (Atomic Energy Commission, Washington, D. C.).

A pronounced microinstability has been observed in the course of a guiding-center simulation of axially symmetric toroidal confinement with the self-consistent electric field. The model and choice of values for the problem parameters follow those reported recently at Novosibirsk, with the sole exception that here the density is greater by a factor of ten. In this case, the electric field is larger, although the ratio of potential to kinetic energies remains at about 0.5%. The instability develops in a transient phase during which ions with large drift excursions are lost to the walls and the plasma seeks an equilibrium potential distribution. The evolution of the potential energy in the m = 2 azimuthal mode displays a high-frequency burst prior to decay to an equilibrium level. In the earlier stages, the electron distribution function is observed to have extremely well-defined gaps, independent of the magnetic moment, at parallel velocities 2.0 to 2.5 times thermal velocity. In time these are filled, but the velocity–space diffusion is preferentially effective for particles with small perpendicular energies, and holes at large values tend to persist. The imposed symmetry prohibits substantial cross-field diffusion by the turbulence. (auth)

1361 (MIAPH-PL-68.4) AMBIPOLAR DIFFUSION IN RF-EXCITED MAGNETO PLASMAS. Plasma Physics Bulletin, Vol. 8, No. 1, June 1968. Robertson, Harry S.; Herring, John J. (Miami Univ., Coral Gables, Fla. Dept. of Physics). 13p. Dep. CFSTI.

A theoretical analysis of ambipolar diffusion in electrodeless, weakly ionized, collision-dominated, rf-excited magnetized plasmas reveals an essential dependence of the steady-state density profile on the electron-density dependence of the net volume-ionization rate. In particular, if and only if the ionization rate is simply proportional to the electron density, the particle fluxes are ambipolar; otherwise there exist divergenceless current cells for which the axial and radial current densities are not everywhere zero. Experimentally, it was found impossible to produce a uniform such plasma in argon, where the ionization process is two-stage, and goes as n^2, whereas the same method of excitation easily yielded a uniform cesium vapor plasma, for which the ionization process is proportional to n. (auth)

1362 (N-68-29888) INDUCTION PLASMA HEATING: SYSTEM PERFORMANCE, HYDROGEN OPERATION, AND GAS CORE REACTOR SIMULATOR DEVELOPMENT. Thorpe, Merle L. (Humphreys Corp., Concord, N. H.). Aug. 1968. 47p. (NASA-CR-1143). CFSTI.

An induction plasma heating system has been studied and optimized. A reliable 80-kW 3-in.-diameter sheath system has been developed which permits efficiently heating argon core gas to arc temperatures surrounded by a high-velocity sheath of hydrogen. This unit will permit studies of mixing, fuel addition, and other related phenomena associated with such a heat addition system. Other studies of hydrogen heating and particle injection into the arc are described. (auth) (STAR)

1363 (RT/FI–(66)5) RAPID TRANSFER OF MAGNETIC ENERGY BY DISCHARGING FOILS. Gatto, M.; Gourlan, C.; Linhart, J. G.; Maisonnier, Ch. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 17p. (In Italian). Dep.

Rapid transfer of large amounts of electromagnetic energy is most frequently effected by discharging a condenser bank into an inductive load. It has often been suggested that such a transfer can be realized using an inductive storage, from which part of the energy is transferred into an inductive load by the opening of a switch. Using an exploding aluminum foil as a switch, an energy of the order of 10^3 J is transferred within about 10^{-3} sec into inductive load. It is believed that better results can be obtained. (auth)

1364 (UCRL-71261) SUPERCONDUCTING MAGNETS FOR CONTROLLED THERMONUCLEAR RESEARCH. Taylor, Clyde E. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 23, 1968. Contract W-7405-eng-48. 15p. (CONF-680714-1). Dep. CFSTI.

From Conference on Superconducting Magnets, Upton, N. Y.

Some of the general considerations for magnetic fields used in controlled thermonuclear research are outlined along with a list of a few of the early superconducting coils which have been built for this purpose and a list of coil systems now planned or under construction. (M.O.W.)

1365 TOWARD FUSION: THE TARGET PLASMA PROGRAM. Snell, Arthur A. Oak Ridge Nat. Lab. Rev., 2: 1-10 (Summer 1968).

The IMP experiment (Injection into Microwave Plasma) at ORNL is described. The apparatus and its function are discussed. (M.O.W.)

1366 NUMERICAL STUDIES OF AN INVERSE PINCH DEVICE. Freeman, John Richard. Albuquerque, N. Mex., Univ. of New Mexico, 1968. 99p.

The inverse pinch configuration has been recognized as a possible means of producing stable, repeatable shock waves in a plasma for laboratory investigation. The simple geometry permits investigation of cases with or without an initial transverse magnetic field in an un-ionized or pre-ionized medium. Previous analytic work for this geometry has been restricted to a snowplow model, sometimes including coupling with the external circuitry. The solution presented here consists of a finite difference, Lagrangian coordinate system solution for a one-fluid hydromagnetic model. The hydromagnetic model chosen includes the effects of a variable degree of ionization, assuming a hydrogenic plasma. Complete flexibility for the initial state of the gas is retained, along with the capability of using either a magnetic field boundary condition or simultaneously solving the external circuit equation for the field–time history. An electrical conductivity dependent on both the temperature and magnetic field is used. Extension for the linear and theta pinch geometries is discussed. Typical examples of the computed solutions are shown, and comparisons with a purely hydrodynamic blast wave model are made. These comparisons indicate that the computed solution tends to a blast wave limit for a small radius center conductor. Comparisons between a snowplow model and the numerical solution are made over a range of initial pressures from 0.25 torr to 10 torr. These comparisons clearly indicate the manner in which the snowplow solution tends to deviate from the complete solution for slower shock speeds. Comparisons are made for the bounce frequency of a computed linear pinch and the frequency predicted from a normal mode analysis, showing that time-dependent oscillations appear to be computed correctly by the numerical solution. Finally, comparisons are made with experimental results for ionizing shocks in hydrogen from an initial pressure of 0.25 torr to 10 torr. Comparisons of the current–time history indicate a good comparison in both timing and shape, while the comparison of the trajectories indicates that the measured luminous front corresponds to the computed piston trajectory. The measured output from magnetic probes implies a correspondence between the measured magnetic front trajectory and the computed shock trajectory. (Disser. Abstr.)

1367 A NEGATIVE V'' WAVY TORODIAL FIELD WITH HELICAL MULTIPOLE. Miyamoto, Kenro (Nagoya Univ.,

Japan). Kakuyugo-Kenkyu, 21: 326-34(Oct. 1968). (In Japanese).

A hybrid of wavy toroidal field and helical multipole is considered to form an average minimum-B toroidal field without internal conductors. The magnetic surface, V'', and the rotational transform angle of the hybrid field are analyzed by the averaging method. Several features of this configuration are derived. (NSA of Japan)

1368 MEGAGAUSS MAGNETIC FIELDS. Szpilecki, J. (Slaska Polytechnic Inst., Poland). Postepy Fiz., 19: 411-30 (1968). (In Polish).

Methods of obtaining megagauss magnetic fields are reviewed. Theta-pinch and Z-pinch methods are discussed in detail. (auth)

1369 EXPERIMENTAL STUDIES OF A DEEP, NEGATIVE, ELECTROSTATIC POTENTIAL WELL IN SPHERICAL GEOMETRY. Hirsch, Robert L. (International Telephone and Telegraph Industrial Labs., Fort Wayne). Phys. Fluids, 11: 2486-90 (Nov. 1968).

Steady electron injection produced a stable, negative electrostatic potential well at the center of a hollow, open, 6.35-cm-diam spherical anode. Even though the primary electron source was localized, electron flow became spherically symmetric at anode currents of the order of 10 mA for anode potentials up to 1.0 kV. Well defined and reproducible oscillations were observed over a lower current range. These oscillations ceased and certain collector characteristics abruptly changed at currents which varied as $V^{\frac{5}{2}}$, suggesting space charge saturation. An electron beam probe verified the presence of the well and measured its depth. The data showed correlation with a simple model and demonstrated the ease with which such wells can be produced. (auth)

1370 LACK OF EQUILIBRIUM DUE TO MAGNETIC GUARDING. Meade, D. M. (Univ. of Wisconsin, Madison). Contract AT(11-1)-1726. Phys. Fluids, 11: 2497-9(Nov. 1968). (COO-1726-4).

A calculation of the initial acceleration of a plasma slab along the null of a magnetic dipole guard indicates that magnetic dipole guarding should not appreciably decrease plasma losses. (auth)

1371 CONFINEMENT OF PLASMA IN A MAGNETIC CUSP FIELD COMBINED WITH AN ELECTROSTATIC FIELD. Sugisaki, Kiwamu (Tokyo Univ.). Jap. J. Appl. Phys., 7: 1387-96 (Nov. 1968).

The confinement of a plasma in a magnetic cusp field combined with an electrostatic field was studied. Theoretical analysis shows that the cusp loss can be suppressed with the use of an adequate electrostatic field. The macroscopic stability of a plasma in such combined fields was also theoretically examined and it was concluded that there is a region in which the plasma is stable against the interchange instability. An apparatus was constructed and preliminary experiments were carried out. The electric field was successfully applied to the plasma, which rotated around the symmetric axis with a uniform angular velocity. When the electric field of a proper strength was applied, the light emitted from the plasma decayed more slowly than in the case of no electric field. It is conjectured to be due to the reduction of the cusp loss of plasma particles. (auth)

Diagnostics

1372 (AD-670170) A USER's MANUAL FOR A COMPUTER PROGRAM TO REDUCE SPECTROGRAPHIC DATA FROM A ROTATIONALLY SYMMETRIC PLASMA. Final Report. Oss, John P. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Jan. 1968. 79p. (ARL-68-3). CFSTI.

A computer program for the reduction of monochromator data from a circular cylindrical plasma column is described in detail. A manual for use of the FORTRAN IV programs is provided along with detailed specifications and listings of the programs. The Abel inversion problem is handled by fitting experimental emission and absorption data to a Jacobi polynomial and inverting the polynomial. The programs presented were used in the reduction of optically thick sources with a typical calculation time of one second when 50 input data points are used and 20 output data points are calculated on an IBM 7094. (auth) (USGRDR)

1373 (AD-671494) A NEW APPROACH TO LOCALIZED DIAGNOSTICS. Measures, R. M. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Sept. 1967. 4p. (AFOSR-68-1404. CFSTI.

A new approach to the attainment of localized information about the condition of a plasma is proposed. In this alternative technique a given atomic transition, within one of the species comprising the plasma, is optically pumped to produce a localized region of enhanced population in the upper state of the transition. This gives rise to an intensification of the spontaneous emission arising from this upper state. Such intensified emission contains information about the conditions within the pumped region of the plasma and can be detected against the background radiation from the rest of the plasma provided, the excitation temperature is small compared to the energy separation of the two states comprising the transition. (auth) (USGRDR)

1374 (AD-671838) COLLECTIVE EFFECTS AND THE SCATTERING OF ATOMIC BEAMS FROM PLASMAS. Goldstein, Byron (New York Univ., N. Y. Dept. of Physics). May 29, 1968. Contract Nonr-285(58). 47p. (TR-N-68-3). CFSTI.

The possibilities of detecting collective effects in laboratory plasmas through the use of atomic beam scattering experiments are investigated. In the impulse approximation the differential cross section for scattering of an atom, with one effective electron, from a two-component plasma is obtained. A model calculation for the scattering of a thermal hydrogen beam from an equilibrium cesium plasma is outlined. An effective range theory is used to describe the atom-electron scattering amplitude and a semiclassical theory is used to describe the atom-ion scattering amplitude. A hydrogen beam of energy .23 eV scattering from a cesium plasma with a particle density of 10^{14} cm^{-3} and a temperature of .23 eV is considered. For these values of the beam and plasma parameters the differential cross section is given in terms of the ion and ion-electron static factors plus integrals over the electron coherent and incoherent dynamic form factors. If the convolution approximation of Vineyard is used to obtain the electron incoherent dynamic form factor in terms of the electron coherent dynamic form factor, it leads directly to the prediction that the spin-flip cross section will be enhanced as the scattering angle goes to zero. (auth) (USGRDR)

1375 (CEA-R-3461) MEASUREMENT OF THE ELECTRON DENSITY OF A PLASMA BY INTERFEROMETRY WITH A He-Ne LASER ($\lambda = 3.39\ \mu$). Belland, Pierre (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb. 1968. 73p. (In French). (EUR-3853). Dep.

The characteristics of the He-Ne gas laser used in a simple interferometric technique have been studied. After passing through the plasma, the beam is reflected back into the laser cavity, and the intensity of the laser itself, modulated by this optical feedback, is used to observe the fringes. Furthermore, owing to the coupling of the two laser transitions 0.63 μ (red) and 3.39 μ (infrared), interferences in the infrared can be detected by a simple photomultiplier monitoring the red line. This method has been applied to two plasma machines (E.P.P.E. and SABLIER) for spatial and temporal measurements of the mean electron density. (auth)

1376 (IPPJ-71) PROBE NOISE IN QUIESCENT PLASMAS. Ikezi, Hiroyuki; Fujiwara, Masami; Takayama, Kazuo (Nagoya Univ. (Japan). Inst. of Plasma Physics). June 1968. 35p. Dep.

The probe noise in quiescent plasmas has been studied experimentally. The observing frequency f normalized to the electron plasma frequency f_{pe} is between 10^{-3} and 1. In the low-frequency range, $f/f_{pe} \ll 1$, the probe noise consists of the shot noise for the electron-collecting region of the Langmuir probe, even when the probe potential is higher than the space potential. The shot noise arising from the probe electron current suffers a reduction due to the transit time effect near the electron plasma frequency. In this frequency range the thermal noise is observed instead of the shot noise. Resonant increases of the noise current are found at the sheath-plasma resonance and at the plasma-wave resonance frequencies. On the other hand the noise current arising from the probe ion current is smaller than the full-shot noise level. The reduction factor for the noise is found to depend on f/f_{pi}, where f_{pi} is the ion plasma frequency. A mechanism for the reduction of the ion shot noise is proposed. (auth)

1377 (N-68-25920) THERMODYNAMIC STUDY OF PLASMAS USING THE PRINCIPLE OF MAXIMUM ENTROPY. Stankiewicz, Norbert (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1968. 26p. (NASA-TN-D-4621). CFSTI.

A maximum entropy (disorder) principle is used to determine the velocity distribution functions in a quiescent plasma (case 1), a current-carrying plasma (case 2), and a viscous plasma (case 3). The Saha equation (at the electron temperature) holds for case 1, and modified Saha equations hold for cases 2 and 3. The modification in case 2 is important only in situations where the directed energy of the electrons is a substantial fraction of the total energy. The results of case 3 are presented in a general form and need simplification before they can be applied to a specific situation. (auth) (STAR)

1378 (N-68-25949) TRANSIENT SPECTRAL STUDY OF DISCHARGES IN COAXIAL PLASMA GUNS. Michels, Charles J.; Hettel, Henry J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 11p. (NASA-TM-X-52340). CFSTI.

Time-varying spectra of argon plasma in a coaxial plasma gun are measured for two geometries. One geometry, operating self-crowbarred, exhibits a fully ionized argon plasma (relatively "clean") for the first moving discharge in the gun. Performance agrees well with earlier snowplow-model theory and experiment. In contrast, the other geometry which operated in the multiple moving-puff mode, exhibits a contaminated discharge with no propellant lines observed. A pyrex gas baffle is the source of contaminants. Performance does not agree with theory. (auth) (STAR)

1379 (N-68-28007) PROFILE MEASUREMENTS OF PLASMA COLUMNS USING MICROWAVE RESONANT CAVITIES. Vlachos, Michael A. W.; Hsuan, Hulbert C. S. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). May 1968. 23p. (NASA-CR-95359). CFSTI.

The density profile of a positive column of a gas-discharge is measured by the comparison of two microwave cavity measurements. The two cavity modes used are the TE_{011} and TM_{020}. (auth) (STAR)

1380 SPECTROSCOPIC INVESTIGATION OF ELECTRON TEMPERATURE DISTRIBUTION IN A NON-EQUILIBRIUM PARTIALLY IONIZED FLOWING PLASMA. Hohnstreiter, Glenn Fredrick. Stanford, Calif., Stanford Univ., 1968. 225p. Thesis.

Spatially resolved electron temperature measurements have been obtained by spectroscopic methods for the case of a non-equilibrium gaseous discharge caused by the passage of direct current between two plane-parallel electrodes in a flowing, partially ionized plasma. These measurements have been made in an arc-heated argon plasma seeded with vaporized NaK, for plasma temperatures ranging from 1300 to 2100°K and electron number densities ranging from 10^{11} to 10^{13} cm^{-3}. The measurements were obtained primarily with an interference-filter photographic method which was developed for this investigation and applied to the Na 3S-3P and Na 3P-3D atomic line radiation. It was found that all of the observed measurements fit into a total of eight discharge classifications which describe the prebreakdown and postbreakdown gaseous-discharge characteristics. The prebreakdown mode of discharge is characterized by anode and cathode effects which result in anode-glow regions and irregular cathode streaking. The prebreakdown effects were observed for applied currents as low as 9 mA, and the electron temperature in the anode-glow case was observed to be very high. The two-temperature model relating the current density and the electron-argon gas temperature difference was found to be consistent with the measurements in the postbreakdown mode, but failed to account for the elevated electron temperatures observed in the prebreakdown anode-glow observations. The correlation between the Na 5890 Å population temperature and the electron temperature was analyzed theoretically. The analysis has shown that a considerable difference can exist between the Na 5890 Å population and electron temperatures due to the escape of resonance radiation. The equation of radiative transfer was solved numerically to determine the effects of self-absorption on the relative intensity emitted by the plasma. The Na 8184 and 5890 Å measurement results were compared experimentally. For values of electron temperature above 1750°K, the Na 8184 Å results yield a temperature measurement which is in good agreement with the radiation-corrected Na 5890 Å measurements, with the exception of measurements directly in the arc-spot regions. (Disser. Abstr.)

1381 APPLICATION OF GAS LASERS TO ELECTRON DENSITY MEASUREMENTS IN PLASMA. Rozkwitalski, Zbigniew (Instytutu Maszyn Przeplywowych, Danzig). Postepy Fiz., 19: 383-401(1968). (In Polish).

A review of methods for measuring electron density in plasma, with the application of gas lasers, is given. Theoretical fundamentals of the method based on the Faraday effect in plasma and some examples illustrating the use of infrared lasers are presented in the first part. A comprehensive discussion of interferometric methods is the subject of the second part. The influence of electrons, atoms, and ions on the optical refractivity of plasmas is examined. Along with the discussion of applicability of conventional interferometers furnished with laser light sources, a detailed description of new laser interferometers is given, in which the properties of optical resonant cavities are utilized. Such an interferometer is composed of a He-Ne laser with the hemispherical cavity and of an additional external cavity coupled with the laser cavity. The examined plasma may be located either inside the additional passive cavity or inside the active laser cavity. The interferometer sensitivity can be increased by employing the coupled 0,63 μ and 3,39 μ lines of the He-Ne laser or by exciting the off-axis transverse $TEM_{m,p,q}$ modes in the additional concave cavity. With an appropriate modification of the system it is possible to measure electron densities within the range of 10^{10} to 10^{17} electrons/cm^3. (auth)

1382 NECESSITY OF PHASE REFERENCE IN LANGMUIR PROBE ANALYSIS OF A POSITIVE COLUMN CONTAINING MOVING STRIATIONS. Drouet, M. G.; Cloutier, G. G. (Univ. of Montreal). J. Phys., E (London), 1: 1035-6(Oct. 1968).

In the presence of moving striations the current-voltage probe characteristic, if swept slowly, presents current oscillations at the striations frequency. It is shown that, owing to spatial variations of the electron temperature in the striation, a phase reference is absolutely necessary for Langmuir-probe analysis. Experimental evidence is presented. (auth) (UK)

1383 PLASMA ELECTRON DENSITY MEASUREMENT WITH A FEEDBACK OSCILLATOR. Simonen, T. C.; Tutter, M. (Institut fuer Plasmaphysik, Garching, Ger.). Rev. Sci. Instrum., 39: 1645-6(Nov. 1968).

A new method is described to measure average plasma number density using a feedback oscillator. This simple technique is applicable for electron densities $n_e \leq 10^{10}$ cm^{-3} and has the novel feature that it can be calibrated to read the density directly on a digital frequency counter. Using an argon plasma, density measurements are made and good agreement is found with independent Langmuir-probe data. The feedback oscillator technique essentially measures the dielectric constant and thus has a wide range of application. (auth)

1384 AUTOMATIC RECORDING WITH A FABRY-PEROT INTERFEROMETER. Fitaire, M.; Deschamps, J. (Laboratoire de Physique des Plasmas, Orsay, France). Rev. Sci. Instrum., 39: 1769-70(Nov. 1968).

A method is described in which a voltage proportional to the pressure is obtained by discharging a regulated current through a thin constantan wire partially immersed in a column of mercury. This column, held at atmospheric pressure, forms one arm of a mercury barometer, the other arm of which contains the interferometer. The resistance of the wire depends upon the height of the mercury column; as the level varies, the voltage of the external generator must vary to maintain a constant current. The use of this method to measure the neutral atom temperature and free electron density of a partially ionized gas is described. (M.O.W.)

1385 RAPID SCAN SPECTROMETERS FOR THE DIAGNOSTICS OF TRANSIENT PLASMAS. Hill, R. A. (Sandia Lab., Albuquerque, N. Mex.). Appl. Opt., 7: 2184-9(Nov. 1968).

An observation that a symmetrical configuration of off-axis paraboloidal mirrors produces an excellent image of an extended slit, while an unsymmetrical configuration produces poor images, has led to a modification of the original Sandia rapid-scan spectrometer and to the design of a new wide-range, rapid-scan spectrometer. The new instrument employs a high-speed rotating mirror in a Littrow arrangement to obtain a spectral scan speed double that of the original spectrometer; e.g., with a 600-lines/mm grating, a spectral scan speed of ~410 Å/μsec is obtained at 1000 rps. Techniques for obtaining an accurate calibration of the spectral scan speed are described, and some examples of spectra which were recorded from a xenon and a hydrogen plasma are shown. (auth)

1386 RELATIVISTIC CORRECTIONS TO THE LIGHT-SCATTERING SPECTRUM OF A PLASMA. Theimer, O.; Sollid, J. E. (New Mexico State Univ., Las Cruces). Phys. Rev., 176: 198-206(Dec. 5, 1968).

The light scattering spectrum of a plasma with drift-displaced Maxwellian velocity distribution is calculated to first order in $\vec{v}/c$ (c = velocity of light). The scattered intensity is obtained from the nonrelativistic Vlasov equation, and from the Lienard-Wiechert potentials produced by electrons which move with velocity $\vec{v}$, and are accelerated by the incident electric and magnetic radiation fields. For the incoherent spectrum, the relativistic effects are found equivalent to an apparent drift-velocity component parallel to the scattering vector $(\vec{k}^s - \vec{k}^i)$ of approximate magnitude $\frac{2}{3}v_e$ (v_e/c) sin $\frac{1}{2}\theta$, where v_e is the rms thermal electron velocity, θ the scattering angle, and $\vec{k}^s$ $(\vec{k}^i)$ the wave vector of the scattered (incident) radiation. In the coherent spectrum, the relativistic corrections are found proportional to the quantity $\omega/c|\vec{k}^s - \vec{k}^i|$. Because of the proportionality to the frequency shift ω, the corrections are negligible for the ion spectrum. (auth)

1387 LINEAR STARK BROADENING IN HIGH-DENSITY LITHIUM PLASMA. Ya'akobi, B. (Hebrew Univ., Jerusalem). Phys. Rev., 176: 227-30(Dec. 5, 1968).

High-density plasma was produced by exploding lithium wires. At the average electron concentration obtained, 2.5×10^{17} cm^{-3}, the measured Stark profile of the 2p-5d line is shown to be almost identical to that calculated for the H_γ line of hydrogen at the same electron concentration. The transition from quadratic to linear Stark broadening is discussed. (auth)

1388 CONDUCTIVITY OF A PLASMA IN A STEADY MAGNETIC FIELD. II. Pradhan, T.; Dasgupta, B. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 176: 309-10(Dec. 5, 1968).

With the aid of techniques used in a previous paper, it is shown without recourse to any approximation that $k_\mu k_\nu \sigma_{\mu\nu}(\vec{k},\omega)/k^2$ is independent of the magnetic field strength. (auth)

1389 MEASUREMENT OF NEUTRAL HYDROGEN ATOM CONCENTRATION IN THE PLASMA PINCH IN THE TOKAMAK TM-3 MACHINE. Kuznetsov, E. I.; Vinogradova, N. D. JETP Lett. (USSR) (Engl. Transl.), 8: 34-7(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 59-63(July 20, 1968).

To determine the concentration of the neutral hydrogen atoms in the plasma pinch in the TM-3 unit, measurements were made of the absolute intensities of the hydrogen Balmer lines H_α and H_β, with simultaneous measurement of the electron density with the aid of a radio interferometer. The electron-temperature data were obtained from earlier measurements of the diamagnetic signal. (M.O.W.)

1390 LANGMUIR'S PARADOX. Sato, Yoshimasa (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., Ser. 4, 19: 102-6(Mar. 1968). (In Japanese).

In order to make clear the so-called "Langmuir's Paradox," the distribution of space potential and the energy distribution of electrons in a low-pressure mercury plasma were observed by Langmuir-probe method. The space potential was highest in the central region of plasma. On the tube wall and at the anode, the potential was about 2 volts lower than at the center of plasma. The space potential distribution acts as the well which traps low-energy electrons, but electrons having higher energies diffuse to the tube wall or anode. The energy distribution was a Druyvesteyn one, the peak value of energy distribution being highest at the center of plasma and lowest on the tube wall. It is concluded that low-energy electrons are collected only in the central region of the plasma. (NSA of Japan)

1391 MEASUREMENTS OF ENERGY DISTRIBUTION IN PLASMA. Sato, Yoshimasa (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., 15: No. 4, 17-29(Mar. 1964). (In Japanese).

The energy distribution of electrons in a helium plasma was measured in spherical and cylindrical discharge tubes. The pressure of helium gas was from 7.8 to 14.3 mm Hg, and the discharge current from 5 to 13.5 mA. For the spherical discharge tube, the energy distribution of electrons was very similar to Druyvesteyn's distribution, and some anisotropy was observed in the velocity distribution of electrons. For the cylindrical discharge tube, near the first standing striation adjacent to the cathode an electron energy distribution was measured, consisting of one electron group having peak value of 23 to 25 eV and the other group of 2 to 5 eV. These results of energy distribution indicate that high-energy electrons from the cathode side lose their energies by collision with helium atoms, ionizing the latter. Subsequent to this, the electrons suffer elastic collisions with atoms, ions and other electrons to attain a thermal equilibrium. It is suggested that the observed energy distribution may represent the process of relaxation of electron energies in the plasma. (NSA of Japan)

1392 DISTORTION OF PROBE CHARACTERISTICS. Sato, Yoshimasa (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., Ser. 4, 19: 107-11(Mar. 1968). (In Japanese).

The distortion of the characteristic curve of a Langmuir probe in a low-pressure mercury plasma was studied. In plasma, when electrons are captured by a probe, the potential gradient increases as electrons flow from surroundings to the probe. Near the probe the space potential exceeds 0.08 V when probe current is 1 mA. In conclusion, the gradient of the probe characteristic curve must be steeper. Accordingly, the electron temperature decreases and the range of energy distribution becomes narrower compared to the values usually obtained. (NSA of Japan)

1393 MEASUREMENT OF PLASMA ELECTRON DENSITY WITH CO_2 LASER INTERFEROMETER. Miyoshi, Syoichi; Shiobara, Shinji (Inst. of Physical and Chemical Research, Tokyo). Kakuyugo-Kenkyu, 21: 73-85(July 1968). (In Japanese).

The electron density of transient plasma was measured with Michelson-type CO_2 laser interferometer. The stability of the CO_2 laser, the directivity of the laser beam, and the accuracy of the density measurement were investigated. (NSA of Japan)

1394 ON EFFECT OF THE ELECTRODE VAPOR ON THE ELECTRON CONCENTRATION IN THE PLASMA OF LOW-CURRENT ARC DISCHARGE IN THE AIR. Semenova, O. P.; Sukhanova, G. B.; Elizar'eva, V. N. (Siberian Inst. of Physics and Tech., Novosibirsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 92-4(1968). (In Russian).

The influence of electrode vapors on electron concentration was studied. Electron concentration in the arc discharge between pure carbon electrodes and in discharges in the presence of Na (Na vapor reduced the temperature from 6500 to 5000°K) was determined taking into account the inhomogeneities of arc discharge from the Li band. (R.V.J.)

1395 CONTINUOUS CROSS MODULATION OF MICROWAVES IN A HELIUM PLASMA. Ware, Kenneth Dale. Ann Arbor, Mich., Univ. of Michigan, 1968. 125p.

Earlier explorations of the cross-modulation technique in the ionosphere demonstrated its usefulness in plasma diagnostics, however, the measurements indicated that the phenomenon was not completely understood. The theoretical analysis is extended in this study to include effects arising from the dc conductivity, electron–ion collisions, and electron density variations, as well as those due to electron temperature variations which were considered in the previous work. Due to the heating effect of a modulated disturbing microwave, all of these plasma properties are disturbed and can cause variations in a second sensing microwave. The analysis describes the relative importance of the properties in continuous cross modulation. One of the most favorable features of cross modulation is that only a relative measurement of the transferred modulation depth as a function of modulation frequency is required. This suggests that the technique might be useful for geometrically unwieldy plasmas since the analysis of standard microwave absorption experiments become very difficult due to the complex scattering pattern resulting from plasma inhomogeneity. The microwave scattering patterns are most complicated when the free space wavelength is comparable to the plasma dimensions, but they only contribute to the normalization of the cross-modulation coefficient in a cross-modulation experiment. Measurements were made in a large volume (4 ft^3) helium glow discharge with 10-cm microwaves. In this case, cross modulation depended primarily on electron density variations. Using independent measurements of electron temperature and density, the transferred modulation depth led to a value for the probability of collision for electron momentum transfer, P_m (18.7 ± 2.1 cm^{-1} torr^{-1} at 0°C), and to a value for the electron–ion recombination coefficient, $\alpha_0(3.6 \pm 2.2 \times 10^{-8}$ cm^3 sec$^{-1})$. These quantities are in good agreement with other published values. (Diss. Abstr.)

1396 THEORY OF ELECTROSTATIC PROBES IN STRONG MAGNETIC FIELDS. Sanmartin, Juan Ramon Losada. Boulder, Colo., Univ. of Colorado, 1968. 186p.

A theory is developed of an electrostatic probe in a fully ionized plasma in the presence of a strong magnetic field. The ratio of electron Larmor radius to probe transverse dimension is assumed to be small. Poisson's equation, together with kinetic equations for ions and electrons, is considered. An asymptotic perturbation method of multiple scales is used by considering the characteristic lengths appearing in the problem. The leading behavior of the solution is found. The results obtained appear to apply to weaker fields also, agreeing with the solutions known in the limit of no magnetic field. The range of potentials for which results are presented is limited. The basic effects produced by the field are a depletion of the plasma near the probe and a non-monotonic potential surrounding the probe. The ion saturation current is not changed but changes appear in both the floating potential V_f and the slope of the current–voltage diagram at V_f. The transition region extends beyond the space potential V_s, at which point the current is largely reduced. The diagram does not have an exponential form in this region as commonly assumed. There exists saturation in electron collection. The extent to which the plasma is disturbed is determined. A cylindrical probe has no solution because of a logarithmic singularity at infinity. Extensions of the theory are considered. (Diss. Abstr.)

1397 LIMITATIONS OF MAGNETIC PROBE MEASUREMENTS IN PULSED DISCHARGES. Tam, Yun-kwong Sebastian. Vancouver, B. C., Univ. of British Columbia, 1967.

A "gradient probe" consisting of two search coils was developed to measure the current density in a pulsed discharge. This probe measures both the magnitude and the gradient of the magnetic field simultaneously, enabling more accurate measurements than the conventional magnetic probe which has only one coil. It has been used to measure the current densities and the magnetic fields in z-pinch discharges in helium at pressures between 500 μ and 4 mm

Hg. The collapse curves obtained agreed with the predictions of a modified snow-plow equation which allowed for the loss of particles from the collapsing current shell. The flow of current in the plasma is distorted by the presence of a probe. Such an effect spoils the spatial resolution so that the measured values of the current density J_p are averages of the true current density J_0 over a finite region. To investigate this, a correction formula which relates J_p to J_o has been developed. The error analyses showed that any scatter in J_p due to experimental errors was magnified twenty times in J_o. For a pulsed plasma, therefore, one should try to reduce the perturbation of the probe instead of relying on the correction procedure. (Diss. Abstr.)

1398 ELECTRON TEMPERATURE MEASUREMENTS OF A HIGH FREQUENCY DISCHARGE IN A HELIUM GAS. Takeda, Susumu; Horio, Toshimasa; Hattori, Chyutestu (Nagoya Univ., Japan). Jap. J. Appl. Phys., 7: 1417(Nov. 1968).

The electron temperature measured by intensity ratio of spectrum lines from a high-frequency (30 MHz) discharge in a He gas is compared with the microwave radiation temperature. It is measured by a method somewhat modified from a Bekefi's device at a frequency of 4000 MHz. (M.O.W.)

1399 APPLICATION OF MICROCHEMICAL ANALYSIS TO DIAGNOSTICS OF LITHIUM PLASMA. Mohri, Akihiro (Kyoto Univ.); Tamura, Sanae. Jap. J. Appl. Phys., 7: 1381-6(Nov. 1968).

A method for measuring diffusion of a plasma produced from a metal of low vapor pressure with the aid of microchemical analysis is presented. A pinholed cavity of a suitable material can be used as a perfect sink of such a plasma stream. The trace amounts of the plasma deposited in the cavity are determined by flame photometry, the sensitivity of which is exceedingly high for alkali metals. An example is shown of the application of this method to the electric drift motion of a laser-produced lithium plasma in a uniform magnetic field. The number of lithium atoms colliding with the wall of a vacuum chamber, determined by flame photometry, shows a fairly good agreement with the density of plasma obtained by a double probe. (auth)

1400 SCATTERING OF CHARGED PARTICLES IN A WEAKLY UNSTABLE PLASMA. Roque, Celso (Univ. of Iowa, Iowa City). Phys. Fluids, 11: 2471-5(Nov. 1968).

The mean-square deflection of suprathermal test particles from a weakly unstable electron plasma is calculated. The instability is assumed to have been driven by a tenuous beam of energetic electrons. The random-phase-approximation expression for the spectral density is used and the electric field energy density of the turbulent spectrum is estimated by the quasilinear theory. It is shown that the mean-square scattering angle can be increased by more than an order of magnitude by a suitable beam density or drift velocity. This enhances the potential usefulness of charged-particle scattering as a diagnostic tool for turbulent laboratory plasmas. (auth)

Kinetics

Refer also to abstracts 1204 and 1566.

1401 (AD-670176) TRANSPORT OF CHARGED PARTICLES THROUGH GASES AND PLASMAS. Final Report, January 1, 1966-January 1, 1968. Oskam, H. J. (Minnesota Univ., Minneapolis. Dept. of Electrical Engineering). Mar. 1968. Contract AF19(628)-5814. 26p. (AFCRL-68-0149). CFSTI.

Results obtained from a theoretical and experimental study of the transport of charged particles through gases and plasmas are summarized. Experimental current-voltage characteristics of a cylindrical hot-cathode gas diode filled with various gases were compared with theoretical curves obtained when using experimental electron-drift velocity data in the calculations. Good agreement was obtained. An experimental tube for studying the influence of space-charge neutralization by positive ions on current-voltage characteristics has been constructed. Application of macroscopic transport equations to the theory of electrophoresis results in a new formulation of this phenomenon. The same method was applied to the theory of cataphoresis. A theoretical study of radial gas density variations in direct current discharge tubes was started. (auth) (USGRDR)

1402 (AD-670218) KINETIC THEORY AND RELAXATION PROCESSES OF WEAKLY IONIZED GASES. Report No. Scientific-1. Delcroix, J. L.; Constantin, A.; Fitaire, M.; Godart, J.; Leibe, E. (Paris Univ., Orsay (France). Laboratoire de Physique des Plasmas). Feb. 1968. Contract F61052-67-C-0048. 34p. (AFCRL-68-0237). CFSTI.

An analytic method to calculate the electronic distribution function in weakly ionized plasma in equilibrium between Joule effect and elastic and inelastic collisions is presented. The results of experimental measurements of the recombination coefficients for plasmas induced by laser are compared with the theoretical ones given by Bates, et al., for hydrogen, after having made an extension of the helium gas. An experiment was conducted to determine the high-frequency field influence on a plasma column (mercury vapor at a .001-torr pressure and electronic density of the order of $10^{11}/cm^3$). The results are given in terms of the ionization of the plasma by the wave and the parametric generation of the low-frequency wave. A finite plasma, having numerous resonance regions, behaves like a parametric amplifier when a small signal is applied on one of these resonances. An experiment is presented where a 2-m W signal at 2700 MHz is amplified with a power gain of 170, the band width being less than 1 MHz. The principles of the nonlinear coherent interaction of two waves in a plasma were verified in the neighborhood of two resonances, cyclotron resonance and hybrid resonance. The nonlinear effect could provide a diagnostic means. The density measurement of the central zone of the plasma studied was performed with a good precision. A new measuring device using three directional couplers and providing an easy way to measure the complex reflection and transmission coefficients of a two-terminal-pair structure is described. (auth) (USGRDR)

1403 (AD-670810) EFFECT OF IONIZATION, DIFFUSION, AND SPACE CHARGE UPON MOBILITY MEASUREMENTS. Ward, A. L. (Harry Diamond Labs., Washington, D. C.). 1966. 4p. CFSTI.

When ionization and diffusion are present, the velocity of an electron avalanche will be increased or decreased, respectively, depending upon whether the avalanche is observed in space at successive times or observed in time at two or more spatial points. The difference of velocity is given by 2 (α)D, where α is Townsend's ionization coefficient and D is the diffusion coefficient. A computer program is used to determine the effect of space charge upon mobility measurements. Illustrative calculations are presented to show the effects of ionization, diffusion, and space charge in the pulsed Townsend discharge. (auth) (USGRDR)

1404 (AD-670844) AN APPLICATION OF CORRELATION RADIOMETRY TO THE STUDY OF PLASMA RADIATION. Report Nos. 40; Scientific-5. Bradford, Phillips V. (Columbia Univ., New York. Plasma Lab.). Mar. 1968. Contract AF19 (628)-5832. 129p. (AFCRL-68-0168). CFSTI.

Several techniques of correlation radiometry of plasma radiation are developed and described. A method of measuring correlation by the direct interference of two microwave signals is applied to the radiation emitted from the plasma column at frequencies near the electron cyclotron harmonics. Applications for some other techniques in plasma diagnostics are also discussed. Strong correlation is found and measured as a function of magnetic field, gas pressure, and axial separation of two sources, for the enhanced emission from the plasma. This indicated that collective processes are responsible for the enhanced emission. These processes are identified by the dependence of correlation on the properties of the plasma. The measurements show an unusual dependence on magnetic field and axial separation, which suggests a particular model of the plasma emission processes which can give rise to enhanced emission. The model is discussed. It describes the enhanced radiation as the result of the conversion of slow electrostatic waves propagating perpendicular to the magnetic field to fast radiating surface waves propagating along a critical layer in the plasma parallel to the magnetic field. The slow electrostatic waves are produced by a beam-plasma interaction. (auth) (USGRDR)

1405 (AD-671528) STUDIES OF ELECTRICAL CHARACTERISTICS OF GASDYNAMIC BOUNDARY LAYERS IN SEEDED DIATOMIC GASES. Final Report, July 1966-January 1968. Goins, E. E.; Norman, Wendell (Arnold Engineering Development Center, Arnold Air Force Station, Tenn. ARO, Inc., Arnold Air Force Station, Tenn.). June 1968. Contract AF40(600)-1200. 71p. (AEDC-TR-68-111). CFSTI.

Calculations are presented of the excess boundary-layer voltage drop attributable to the conduction of current through a thermal boundary layer on the electrodes of an MHD accelerator operating with seeded air or nitrogen, using two-temperature model of Kerrebrock. For a laminar boundary layer, the excess boundary-layer voltage drop is found to be a linear function of pressure, relatively insensitive to free-stream temperature and seed fraction, and larger for air than for nitrogen. Experiments conducted in a shock tube showed an asymmetry in the voltage distribution for seeded air, with the cathode drop approximately 30 V and the anode drop approximately 10 V. (auth) (USGRDR)

1406 (AD-671837) TRANSPORT THEORY OF PARTIALLY DEGENERATE PLASMA. Lampe, Martin (New York Univ., N. Y. Dept. of Physics). May 1968. Contract Nonr-285(58). 18p. (TR-N-68-1). CFSTI.

The transport coefficients of a high-temperature, weakly coupled plasma of nondegenerate ions and partially degenerate electrons (i.e., stellar matter) are calculated by means of a Chapman–Enskog solution of the quantum Lenard–Balescu kinetic equation. Both electron–electron and electron–ion collisions are included. The leading term of the transport coefficients, the Coulomb logarithm, is evaluated exactly and relatively simple for all degrees of electron degeneracy. The method is applicable to any partially degenerate system with weak, long-range particle interactions. (auth) (USGRDR)

1407 (CNAEM–59) UNIFIED TRANSPORT THEORY OF TWO-TEMPERATURE FULLY IONIZED PLASMAS. Daybelge, Umur (Cekmece Nuclear Research Center, Istanbul (Turkey)). July 1968. 20p. Dep.

The transport efficients of a nonisothermal, fully ionized plasma have been determined without any cutoff procedure. The theory is exact in the sense that it is valid not only for large values of the Coulomb logarithms themselves but also for large values of their arguments. The effect of interactions between electrons and plasma oscillations has been incorporated in the theory. External magnetic fields have not been considered. (auth)

1408 (COO-1695-13) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 6. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). Sept. 15, 1968. Contract AT(11-1)-1695. 22p. Dep. CFSTI.

The purpose of this research is to investigate the ability of a short pulse of electron cyclotron resonance radiation to produce an anisotropic energy distribution of electrons in a plasma and the instabilities and waves produced by this anisotropy. In particular, the nature of the rf heating mechanism and the behavior of the radiation emitted from the plasma will be considered. The ECR device was operated to obtain wall bremsstrahlung measurements, plasma diamagnetism, electron flux, and electron density in the discharge. An instability in the operation of the device was observed. Theoretical work is under way to determine the nature of this instability as well as a new method for evaluating the eigenfrequencies of a microwave cavity filled with a plasma of variable density. Relativistic x-ray bremsstrahlung theory was expanded. (M.O.W.)

1409 (INR-P-926) KINETIC DESCRIPTION OF PLASMA IN AN EXTERNAL FIELD. II. RING APPROXIMATION. Kuszell, A.; Senatorski, A. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 44p. Dep.

The kinetic equation for plasma in an external nonuniform and nonstationary electromagnetic field in so-called ring approximation is derived. The system is described by two coupled equations, the kinetic equation for one-particle distribution function, and the Vlasov equation linearized around the solution of kinetic equation. The last equation determines an auxiliary function appearing in the collision operator. Method of solution of this equation based on hydrodynamical concepts is proposed. In the zeroth order of approximation (hydrodynamic approximation), the collision integral is found explicitly. The time evolution of the contribution of an initial two-particle correlation is discussed. (auth)

1410 (JINR–P9–4042) DISSIPATIVE SPECTRAL TRANSFORMATIONS OF TURBULENT PULSATIONS IN PLASMA. Makhan'kov, V. G.; Tsytovich, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1968. 15p. (In Russian). Dep.

Using hydrodynamic equations, the nonlinear plasma currents are obtained if ω_-, $k_-V_{Te} \ll \nu_e$, $\omega_- = \omega_1 - \omega_2$, $|\vec{k}_-| = |\vec{k}_1 - \vec{k}_2|$, $\omega_{1,2}$, $k_{1,2}$ (frequences and wave vectors of interacting pulsations). They correspond to those obtained earlier on the basis of Vlasov equations. The excitation of low-frequency acoustic waves due to the hf wave beam is discussed. It turns out that, in particular cases, dispersion of low-frequency acoustic waves is determined by hf wave energy density. (auth)

1411 (JUL–524–PP) STUDY OF THE ACCELERATION OF A PLASMA THROUGH A PULSED ELECTROMAGNETIC TRAVELLING FIELD. Bieger, Wolfgang (Kernforschungsanlage, Juelich (West Germany). Institut fuer Plasmaphysik). May 1968. 70p. (In German). Dep.

The process in the acceleration of a plasma through a pulsed electromagnetic traveling wave was investigated in an experiment in which a wave with increasing velocity was propagated by a special transmission chain. The plasma was produced in a conical ring discharge and introduced into the solenoid of the chain. The temperature is sufficiently high to prevent a penetration of the field of the traveling wave during the acceleration period so that a magnetic bottle can be formed. If the density of the plasma at the beginning of the acceleration is sufficiently small, so that the magnetic pressure of the bottle exceeds the kinetic pressure of the plasma, the plasma is accelerated to velocities up to 10^8 cm/sec. The process can then be described by a free-particle model which gives an energy distribution for the ion of the accelerated plasma which agrees well with the experimentally determined values. It follows that during the complete acceleration period a magnetic bottle must exist so that the relatively small losses are to be considered only when an electrostatic field is assumed in the layer between plasma and magnetic field. The losses are limited partially by reflection of the ions from the acceleration direction in the collision with the bottle. They can be reduced by the superposition of a quasi-static magnetic field on the traveling-wave field. In case these fields are antiparallel, the bottle appears to be stable up to high field strengths of the superimposed field. It follows, therefore, that the acceleration of a plasma by a harmonic traveling wave can be effective at least for low densities and high conductivities. A simple model for this case is discussed. (tr-auth)

1412 (LA–3990) PROCEEDINGS OF THE APS TOPICAL CONFERENCE ON NUMERICAL SIMULATION OF PLASMA HELD AT THE UNIVERSITY OF CALIFORNIA, LOS ALAMOS, NEW MEXICO, SEPTEMBER 18–20, 1968. (Los Alamos Scientific Lab., N. Mex.). Sept. 30; 1968. Contract W-7405-eng-36. 177p. (CONF-680914). Dep. CFSTI.

Separate abstracts were prepared for the 23 individual papers. (M.O.W.)

For abstracts of individual papers see: 1357–1360, 1413–1429, 1492, and 1493.

1413 (LA–3990, pp A1,1-10) FINITE-SIZE PARTICLE MODEL FOR PLASMA SIMULATION. Dawson, J. M.; Hsi, C. G.; Shanny, R. (Princeton Univ., N. J. Plasma Physics Lab.).

A finite-size particle model is being developed for plasma simulation in one, two, and three dimensions. The particles have a Gaussian distribution of charge. These clouds pass freely through each other but no internal motion is allowed. This model suppresses the short-wavelength field fluctuations which give rise to collisional effects while correctly modeling the long-wavelength collective modes. A code has been developed for the one-dimensional case and the results are compared with earlier ones from the sheet model. Excellent agreement is found for particles with radii up to one Debye length and general agreement is found for even larger particles. The model is being extended to two and three dimensions. The use of particles with different charges, but with the same charge-to-mass ratio are considered. Such a model behaves the same as far as the Vlasov equation is concerned. This extension will allow the bulk of the plasma to be simulated by a few particles with large charges, while a large number of particles with a small charge on each may be used to represent the most interesting regions of phase space (for example, a beam). (auth)

1414 (LA–3990, pp A2,1-7) INVESTIGATIONS OF ELECTROSTATIC OSCILLATIONS OF A NON-MAXWELLIAN PLASMA. Shanny, R.; Kruer, W. L.; Dawson, J. M. (Princeton Univ., N. J. Plasma Physics Lab.).

The electrostatic sheet model has been used to investigate (1) the finite-amplitude oscillations of a plasma with a Maxwellian velocity distribution plus a large flat tail, and (2) the driven oscillations of an initially Maxwellian plasma. For the first problem the dispersion relation shows that there are two branches for ω for a given k. Beating between two waves has been observed and it checks with theory. The existence of two branches allows for resonant mode coupling, and some evidence for this has been seen. However, other nonlinear processes, such as those associated with trapped particles, may be important and further work is required to sort out the important effects. In the second problem a forcing term of the form $\sin(kx - \omega t)$ was applied to an initially Maxwellian plasma. Here the resonant wave grew to large amplitudes, pulling out a long tail on the distribution. The plasma continued to heat (gain energy) to the end of the run. For strong driving, a second bump formed in the distribution. Waves with nearby phase velocity (nonresonant and nonharmonic waves) grew to large amplitudes. A discussion of these results is given. (auth)

1415 (LA–3990, pp A3,1-6) NUMERICAL STUDIES OF NONLINEAR ION–ACOUSTIC WAVES. Armstrong, T. P. (Kansas Univ., Lawrence); Montgomery, D. (Iowa Univ., Iowa City).

The nonlinear Vlasov equation for ions coupled with a fluid model for the neutralizing electrons has been integrated numerically. Collisionless damping of ion–acoustic waves has been observed in the model. The characteristics of the damping of large-amplitude waves are qualitatively similar to experimental

observations as well as to prior numerical calculations on the damping of electron plasma oscillations. Namely, the initial damping is more severe than that expected from linearized theory and the long-time regime damping rate is smaller than the linear damping rate. (auth)

1416 (LA-3990, pp A4.1-10) NUMERICAL SIMULATION OF WARM TWO-BEAM PLASMA. Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.).

One-dimensional numerical simulation of plasmas consisting of two unequal warm beams has shown flattening of the small beam and, in most cases, a strong single-mode structure at about the wavelength of largest linear growth rate, accompanied by an eddy-like arrangement of trapped particles in phase space. The total electrostatic field energy first increases at the linear growth rate and then, after saturating abruptly, decreases at about the same rate to an intermediate level where a much slower decay begins. (auth)

1417 (LA-3990, pp A6.1-9) PERSISTENTLY RECURRING NONLINEAR WAVES ARISING FROM THE TWO-STREAM INSTABILITY. Armstrong, T. P. (Kansas Univ., Lawrence); Freidberg, J. P. (Los Alamos Scientific Lab., N. Mex.).

The full nonlinear cold plasma equations have been solved numerically for a counterstreaming electron–ion plasma. A class of linearly unstable longitudinal electrostatic waves which stabilize nonlinearly before particle over-taking occurs has been found. These waves occur in periodic systems where the boundaries are open circuited and only one wavenumber (in the neighborhood of the instability boundary) is linearly unstable. Relevant existing analytical theories are briefly reviewed and the formulation of a new theory suggested by the numerical data is outlined. (auth)

1418 (LA-3990, pp A7.1-16) DYNAMICS OF INHOMOGENEOUS PLASMAS. Schneider, H. M.; Bers, A. (Massachusetts Inst. of Tech., Cambridge).

Small but finite amplitude excitations of an inhomogeneous plasma generate large amplitude charge density oscillations and nonlaminar motions of the plasma particles. The details of this nonlinear and nonlaminar motion can best be studied by a computer simulation of the dynamics of the plasma. The results of both small- and large-amplitude excitations of a plasma with a smooth density profile are presented. The transition from linear to nonlinear oscillations are discussed and the conditions for the onset of nonlaminar motions are given. It is shown that for small-amplitude excitations a linearized Lagrangian description correctly predicts the detailed dynamics up to the time that overtakings occur. The Eulerian description can only be used to describe averaged field quantities such as the voltage across the plasma. For large-amplitude excitations the dynamics are soon dominated by nonlaminar effects which lead to a thermalization of the energy imparted to the plasma by the initial excitation. (auth)

1419 (LA-3990, pp B2.1-8) APPROACH TO EQUILIBRIUM FOR A COLLISIONLESS SYSTEM. Hohl, Frank (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center).

One-dimensional computer models are used to simulate the evolution of collisionless plasmas and self-gravitating systems. The evolution for various initial distributions is investigated. It is found that for simple initial conditions the quasi-equilibrium state which is reached after several plasma periods is close to the Fermi distribution proposed by Lynden-Bell. For more complicated initial conditions the Lynden-Bell distribution does not adequately describe the final state of the system. (auth)

1420 (LA-3990, pp C1.1-5) ONE-DIMENSIONAL INITIAL-VALUE PROBLEMS WITH A TRANSVERSE MAGNETIC FIELD. Morawetz, Cathleen S. (New York Univ., N. Y. Courant Inst. of Mathematical Sciences).

A charge-neutral collision-free plasma is studied numerically in the following way: First and second moments are taken of the collision free one-dimensional time dependent Vlasov equations coupled with Maxwell's equations using the condition of charge neutrality instead of Poisson's equation. Conditions are investigated under which (a) an asymptotic adiabatic formula may be used for the electrons and (b) the third moments of the ions may be neglected. The resulting system is solved numerically for certain initial and boundary-value problems with two-point accuracy. The neglected third moments are computed using 8000 particles and shown to be negligible. It is shown that as the pressure of the gas increases the strength of a breaking disturbance decreases rapidly. (auth)

1421 (LA-3990, pp C2.1-16) NUMERICAL SIMULATION OF AXISYMMETRIC, COLLISIONLESS, FINITE β PLASMA. Dickman, D. O.; Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.).

A numerical simulation method for time-dependent, axisymmetric collisionless, finite β plasma is described and applied to mirror modes in θ pinches and to rotational and tearing modes in Astron. It is shown that the mirror modes cause an increase of axial thermal velocities and the long-time development of a gross bumpy structure in the θ-pinch plasma. The Astron plasma layer first develops tearing modes in agreement with linear theory, but at later times the wavelength of this mode increases by coalescence until the plasma is completely re-assembled. (auth)

1422 (LA-3990, pp C3.1-11) TWO-DIMENSIONAL SIMULATION OF SHOCK WAVES IN COLLISIONLESS PLASMAS. Shonk, Carl R.; Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.).

Analytical approaches to the calculation of collisionless shock waves are discussed. Difficulties prevalent in these calculations can be avoided by numerical simulation. Simulation is attractive since plasma particle interactions are simple and well known. In the model discussed here, ions move correctly under self-consistent fields. Electrons are treated as a massless, adiabatic fluid which moves so as to maintain charge neutrality to lowest order. Ion motion is nonadiabatic due to interaction with the turbulent fields in the plasma. Particle motion is in a plane perpendicular to the magnetic field. A suitable set of finite-difference equations for the particle motion is proposed, and their solution by a "Particle-in-Cell" technique is discussed. Results are presented for several cases of interest. Strong mode structure having wavelength near c/ω_{pi} is observed. (auth)

1423 (LA-3990, pp C4.1-8) CONSERVATIVE DIFFERENCE SCHEMES FOR THE FOKKER–PLANCK EQUATION. Whitney, James (Columbia Univ., New York).

A numerical scheme which ensures conservation of mass, momentum, and energy is developed for solution of the Fokker–Planck kinetic equation. As an example of the method, the long-time thermal relaxation of a deuterium–electron plasma is computed. (auth)

1424 (LA-3990, pp C5.1-4) SOLUTION OF FREE BOUNDARY PROBLEMS BY THE METHOD OF STEEPEST DESCENT. Bloch, Eugene; Garabedian, Paul (New York Univ., N. Y. Courant Inst. of Mathematical Sciences).

A systematic iterative scheme was developed for the numerical solution of steady free-boundary problems of fluid dynamics and plasma physics by the method of finite differences. The scheme uses paths of steepest descent associated with familiar variational principles to specify an artificially time-dependent formulation of the problem that is readily handled numerically. A new technique of conformal mapping enables us to determine the shape of the free boundary by means of difference equations over a fixed rectangle. The method is applicable to a variety of models involving just two independent variables. (auth)

1425 (LA-3990, pp C6.1-8) MHD SIMULATION OF COAXIAL PLASMA FLOW. Butler, T. D.; Cook, J. L.; Morse, R. L. (Los Alamos Scientific Lab., N. Mex.).

The results are presented of a numerical simulation of a coaxial plasma gun operating in the puffed gas mode. A compressible MHD model is used. A wake shock is seen to form on the axis downstream from the center electrode. The heated plasma inside the shock shows a dual structure; a hot inner core is surrounded by a cooler region just inside the shock. A quasi-continuous flow pattern is seen to develop. (auth)

1426 (LA-3990, pp C7.1-8) INITIAL RESULTS FROM A TWO-DIMENSIONAL LAX–WENDROFF HYDROMAGNETIC CODE. Freeman, J. R.; Lane, F. O. Jr. (Sandia Corp., Albuquerque, N. Mex.).

The success of a number of one-dimensional hydromagnetic codes in predicting the gross dynamical behavior of a variety of plasma devices has led to an attempt to extend the calculations to two dimensions. An explicit Eulerian difference scheme of the Lax–Wendroff variety was chosen to provide a reasonable level of accuracy for a relatively coarse space–time net. A staggered array with provision for fixed regions of fine zoning was used. Numerical stability was achieved by using a third-order smoothing technique reported recently by Lapidus. All calculations assumed currents which were directed solely in the theta direction. A simple two-dimensional high-density theta pinch, incorporating a mirror field at the ends, was chosen as a test example. The hydromagnetic equations included the effects of thermal conduction and a temperature-dependent electrical conductivity. Separate ion and electron temperatures were calculated. Computed results for this example are shown. (auth)

1427 (LA-3990, pp D1.1-6) CLOUD-IN-CELL COMPUTER EXPERIMENTS IN TWO AND THREE DIMENSIONS. Birdsall, C. K.; Fuss, D. (California Univ., Livermore. Lawrence Radiation Lab.).

Simulation of fusion plasmas with particle forces dominated by electrostatic fields in applied B fields is the major application of the cloud-in-cell approach, CIC. The charged particles (clouds) have finite size and can pass through one another; they obey a Coulomb force law when separated and a linear force law when overlapping, allowing simple harmonic (plasma) oscillation at small separation. Uniform-density square clouds are used in 2D (SQRPLA) and cubic clouds in 3D (CUBPLA). The object has been to reduce some of the spurious short-wavelength, high-frequency effects produced in the zero-size-particle, nearest-grid-point method, ZSP-NGP; some reduction has been achieved, as shown in comparison runs. SQRPLA with zero potential boundaries in a 48 × 48 grid, has been applied to diocotron, Alice, and loss cone distribution problems with excellent energy conservation at low densities, degrading to good at high densities measured by $(\omega_{pi}/\omega_{ci})^2 \cong 10$; with periodic boundary conditions, SQRPLA has been used up to about $(\omega_{pi}/\omega_{ci})^2 \cong 100$. CUBPLA, with a 36 × 36 × 36 grid, has been run but sparingly, awaiting evolution of improvements in initial conditions and diagnostics in the more easily handled and economical 1D and 2D CIC codes. (auth)

1428 (LA-3990, pp D2.1-5) THEORY AND EXPERIMENTS FOR A PLASMA CONSISTING OF CLOUDS INTERACTING WITH CLOUDS (CIC) WITH AND WITHOUT A SPATIAL GRID. Birdsall, C. K.; Langdon, A. B.; McKee, C. F.; Okuda, H.; Wong, D. (California Univ., Berkeley).

It is important to theoretically describe computer experiments in order to justify and understand the computational model and to improve the results. Therefore, a theory is being developed for a computer plasma model which uses charged clouds (CIC, either clouds-in-cells or clouds-interacting-with-clouds). The major effects of and reasons for using finite-size particles are to suppress interactions at wavelengths smaller than the cloud thickness and to reduce the noise at high frequencies enhanced by particle and grid crossing. These reductions have been observed in 1, 2, and 3D experiments. The object is to predict and measure these effects in some detail and to begin understanding the more difficult problem of the remaining unphysical noise due to the use of grids and small numbers of particles in plasma simulation. The beginnings are presented of plasma cloud theory with computer verification of some results, mostly in one dimension, with and without grids. The problems studied include the interaction force; many-particle cold plasma oscillations; warm (Vlasov) plasma linearized dispersion relation, shielding, and field fluctuations in equilibrium. (auth)

1429 (LA-3990, pp D6.1-7) POTENTIAL CALCULATION. Hockney, R. W. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center).

Methods are described for calculating the potential on a uniform rectangular mesh due to a distribution of charge on the same mesh. Revised operation counts are given for a direct method of solving the 2D Poisson equation which solves the difference equations exactly in the time of 5 or 6 S.O.R. iterations. The rate of error decay for different iterative methods has been studied and the cyclic Chebysher method is found to have the best performance. A Fourier Transform technique is described for solving the case when the force of interaction between charges is arbitrary and this is applied to an isolated system of point charges moving in a plane. All the results are supported by timing working programs on the CDC 6600. The cycle time on a (256 × 256) mesh in space, with 50,000 particles is 4.5 secs for a 2D rod model and 10.4 secs for an isolated system with arbitrary forces. (auth)

1430 (MATT-638) NONLINEAR HIGH-FREQUENCY PLASMA CONDUCTIVITY. Salat, A.; Kaw, P. K. (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1968. Contract AT(30-1)-1238. 10p. Dep. CFSTI.

Numerical results are presented for the hf nonlinear conductivity of a fully ionized plasma. Special attention was given to the case when the frequency ω of the applied electromagnetic field is close to the electron plasma frequency ω_p. Apart from its intrinsic theoretical interest, this frequency range is of relevance to the problem of production and heating of plasmas by laser irradiation. (M.O.W.)

1431 (MATT-645) HYDROMAGNETIC EQUILIBRIUM OF TOROIDAL PLASMA WITH CIRCULAR HARD CORE. Pacher, Horst D. (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1968. Contract AT(30-1)-1238. 30p. Dep. CFSTI.

The hydromagnetic equilibrium problem is solved for an annular toroidal plasma having a toroidal hard core in the limit of large aspect ratio and zero azimuthal plasma current. The plasma is enclosed in a toroidal perfect conductor and subjected to an external field. Plasma pressure is taken to vary directly with the logarithm of distance from the hard core. It is found that the isobaric surfaces shift in a plane perpendicular to the axis. The shift is found to consist of three terms: a shift away from the axis depending only on the curvature and the radius of the outer conductor, a shift away from the axis depending only on the pressure and the hard core current which increases with distance from the hard core, and a shift toward the axis depending on the outer conductor radius, the plasma pressure, and the hard core current. The maximum ratio of plasma pressure to poloidal field pressure for which the theory is applicable in any case is found to be 0.75 times the aspect ratio. (auth)

1432 (N-68-25821) PLASMA BOUNDARY INTERACTIONS. 2. Aisenberg, S.; Hu, P.; Rohatgi, V.; Ziering, S. (Space Sciences, Inc., Waltham, Mass.). June 1968. Contract NASw-1014. 68p. (NASA-CR-1072). CFSTI.

A study has been made of additional factors describing plasma-boundary interactions. The theoretical analysis of the sheath has been extended to include a transverse plasma flow outside the sheath region. The sheath model has been made more general, and also reveals the importance of the accommodation coefficients at the boundary surface. The presence of ionization and collisions in the sheath has also been studied theoretically. The interpretation of the experimentally observed threshold in the tangential electrode drag as a function of transverse magnetic field and of arc current has suggested the possibility of a threshold in the tangential accommodation coefficient. The threshold tangential energy appears to be proportional to the sputtering threshold and can be related to the threshold for displacement of surface atoms. The relationship between plasma phase velocity and particle velocity was studied and it was shown that there is not necessarily a simple connection: The related problem of arc retrograde motion (where plasma phase and particle motion have opposite signs) was studied and a simple model was proposed. It appears that the plasma propagates in the retrograde direction because of an increased net ion generation rate due to the inhibited diffusion loss of ions and electrons in the region of higher magnetic field. The importance of direct measurement of ion and atom velocity by means such as the Doppler shift is discussed. (auth) (STAR)

1433 (N-68-27401) PARTITION AND RECOMBINATION ENERGY IN THE DECAYING RARE GASES PLASMAS. Chen, Che Jen (Jet Propulsion Lab., Pasadena, Calif.). Oct. 1, 1967. Contract NAS-7-100. 10p. (NASA-CR-89819). CFSTI.

In the collisional-radiative electron-ion recombination regime, the energy liberated from each recombination is partly carried away by a third colliding free electron and partly transformed into radiation. The partition of the energy among the electrons and radiation is obtained by comparing the probability of electron collisional de-excitation at different atomic-energy states, calculated by using Gryzinski's formulation, and the spontaneous transition probability of bound electrons to all lower states evaluated by using the sum rule of line strength and the central field approximation. A recombination-dominated decaying plasma is produced by a discharge tube energized with a capacitor bank. After cessation of the discharge current, the electron density, electron temperature, and atom temperature are measured by using both microwave and electrostatic probes, the spectral-line ratio method, and a fast-rise-time resistance thermometer, respectively. The partition of the recombination energy under different conditions for He, Ne, Ar, Kr, Xe gases is determined from a solution of the electron energy equation. The experimental results are in good agreement with the theoretical predictions. The oscillator strength of the resonance lines for the five rare gases is also presented. (auth) (STAR)

1434 (N-68-27701) PHYSICAL PROCESSES IN THE MAGNETO-PLASMADYNAMIC ARC. Semiannual Report, September 1967-March 1968. Lovberg, R. (California Univ., La Jolla, San Diego). May 1968. 34p. (NASA-CR-95144; SAR-4). CFSTI.

Experiments directed toward magneto-plasmadynamic behavior within its region of current flow were performed on a tungsten cathode which achieved about 3400°K in pulsed operation. Magnetic field probes and current loops determined that the arc had the form of a rotating spoke with uniform electron temperatures throughout and an ion density nearly independent of radius. The plasma within the current spoke was counterstreaming radially inward. Although no azimuthal currents were detected in the body of the arc, a current of about 50 amperes was flowing azimuthally in the anode sheath with the resulting J × B force directed inward and of sufficient magnitude of overcome the net centrifugal force. Ions seemed to carry one-third of the radial arc current with the electrons carrying the remainder. (STAR)

1435 (N-68-28449) INVESTIGATION OF THE PLASMA BEHAVIOR IN AN AC ELECTRIC FIELD. PART 2. Pasichnyk, L. L.; Ovcharenko, A. A. Translated from Ukr. Fiz. Zh., 12: 2029-33(1967). 6p. (NASA-TT-F-11769). CFSTI.

The results of an investigation of the behavior of a plasma in the presence of both an ac electric field and a magnetic field are presented. The relative change in the ac electric field in the discharge chamber with plasma was measured under different magnetic field intensities (0 to 200 Oe) plasma densities (10^8 to 10^{10} cm^{-3}), gas pressures (10^{-1} to 10^{-2} torr) and frequencies (1.5×10^5 to 1.5×10^6 Hz). Comparison of the experimental data with the theoretical calculations shows that the ion component of the plasma must be taken into account. (auth) (STAR)

1436 (N-68-30031) DYNAMICS OF A ONE-DIMENSIONAL PLASMA SHEATH. Hohl, Frank; Staton, Leo D. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). July 1968. 56p. (NASA-TN-D-4651). CFSTI.

Analytical and numerical methods are used to investigate a bounded one-dimensional plasma with a fixed neutralizing ion background. A variational method is used to show that a large class of stationary solutions of the nonlinear Vlasov equations represent minimum energy states. The consequence of the minimum-energy property is that the stationary states, which represent minimum energy configurations, can never be completely reached. However, numerical experiments which simulate the system reveal the interesting property that the plasma approaches its stationary state closely whenever the initial energy is not too different from the energy of this stationary state. (auth) (STAR)

1437 (N-68-30295) EXPERIMENTAL AND ANALYTICAL STUDIES OF PLASMA TRANSPORT PROPERTIES. Semiannual Progress Report, December 1, 1967-May 31, 1968. Bershader, Daniel (Stanford Univ., Calif. Dept. of Aeronautics and Astronautics). July 1, 1968. 34p. (NASA-CR-95874). CFSTI.

The theoretical effort consisted in extending the earlier work on development of formulas for calculation of transport coefficients of a stable, multicomponent plasma in the presence of a magnetic and an alternating electric field, in accordance with the Chapman-Enskog theory. Numerical values of electron thermal and electrical conductivities for helium and argon were evaluated and compared. Major results of the recent experimental effort include a successful evaluation of electron density profile in the thermal boundary layer behind the reflected shock. Information has also been obtained on the nonequilibrium ionization-wave interactions in the reflection shock regime. Instrumentation work continued on a more sophisticated thin-film heat transfer gauge for use in ionized gases, as well as continuing work on extending the capabilities of the high-response capacitative end-wall pressure gage. (auth) (STAR)

1438 RELAXATION OF ANISOTROPIC PLASMAS WITH DYNAMIC SHIELDING. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Phys., 216: 488-98 (1968).

The relaxation of a strongly anisotropic two-component-plasma is treated by using the Balescu-Lenard equation, i.e., taking into account collective effects. The relaxation process is described by parallel and perpendicular temperatures as functions of time; it is assumed that the distribution functions remain elliptical. The result is that collective effects are only significant if the ratio of electron and ion temperatures is very small ($<10^{-4}$) or very large ($>10^{+2}$). (auth)

1439 THE PROPERTIES OF A DRIFTING AND DIFFUSING PULSE OF ELECTRONS AND TOWNSEND'S COEFFICIENT OF IONIZATION α_T. Huxley, L. G. H. Aust. J. Phys., 21: 761-4 (Oct. 1968).

The properties of an ionizing and traveling pulse of electrons, spreading by diffusion as it advances through the gas, are examined. (M.O.W.)

1440 DYADIC IN THE THEORY OF WAVES IN INHOMOGENEOUS WARM PLASMAS. Burman, R. (Univ. of Western Australia, Nedlands). Proc. IEEE (Inst. Elec. Electron, Eng.), 56: 1738-40(Oct. 1968).

Waves in inhomogeneous warm magnetoplasmas with static pressure gradients are discussed. A dyadic used in formulating the theory is applied to the case of planar stratified plasmas. (auth)

1441 RESONANT FOUR-WAVE INTERACTION OF ELECTRON-PLASMA OSCILLATIONS. Davidson, R. C. (Univ. of California, Berkeley). Phys. Rev., 176: 344-50(Dec. 5, 1968).

The time evolution of a uniformly turbulent ensemble of electron fluids is studied in the electrostatic approximation. A kinetic equation for the action density is obtained in the long-wavelength limit, in which resonant four-wave processes cause the nonlinear transfer of energy in the oscillation spectrum. It is shown that the entire region of $\vec{k}$ space (within the limits of the simple-fluid model) is accessible to resonant four-wave interactions. Such four-wave mode coupling serves as a mechanism for the transfer of wave energy into shorter wavelengths. (auth)

1442 ELECTRON-TEMPERATURE DEPENDENCE OF ELECTRON-ION RECOMBINATION IN ARGON. Mehr, F. J.; Biondi, Manfred A. (Univ. of Pittsburgh). Phys. Rev., 176: 322-6(Dec. 5, 1968).

A 3-mode microwave apparatus is used to study the dependence of the dissociative recombination coefficient $\alpha(Ar_2^+)$ on electron temperature T_e over the range $300°K \leq T_e \leq 10{,}000°K$ while the ion and gas temperatures remain at 300°K. A high-Q cavity mode is used to ionize the gas periodically, a second high-Q mode is used to determine the decay of electron density during the afterglow from the change of resonant frequency of the cavity, and a nonresonant waveguide mode is used to apply a constant microwave heating field to the electrons. At $T_e = 300°K$, a value $\alpha(Ar_2^+) = (8.5 \pm 0.8) \times 10^{-7}$ cm^3/sec is obtained from analysis of recombination-controlled electron-density decays using a computer solution of the electron continuity equation which includes recombination and ambipolar diffusion terms. Over the range $300°K \leq T_e \leq 10{,}000°K$, the coefficient $\alpha(Ar_2^+)$ is found to follow a simple $T_e^{-0.67}$ variation. This result is reconciled with Fox and Hobson's $T^{-1.3}$ variation, obtained under conditions where $T_e = T_i = T$, on the basis of their changing Ar_2^+ vibrational-state populations with changing temperature. Finally, it is noted that the $T_e^{-0.67}$ variation may be evidence for appreciable electron capture via the indirect as well as the direct dissociative process. (auth)

1443 RADIAL DISTRIBUTION FUNCTION FOR A QUANTUM PLASMA. Storer, R. G. (Flinders Univ. of South Australia). Phys. Rev., 176: 326-31(Dec. 5, 1968).

The radial distribution function for a plasma is calculated for small interparticle separations. Quantum effects are taken into account by using either a modification of the path-integral technique or the equivalent sum-over-states expression under the assumption that the charged particles interact via a shielded Coulomb potential. (auth)

1444 ION ENERGIES AT THE CATHODE FOR CONDUCTION THROUGH RAREFIED GASES. Schoonover, D. R. (Univ. of Missouri, Rolla). Phys. Rev., 176: 331-6(Dec. 5, 1968).

The characteristics of ion energies at the cathode are derived from collisional ionization cross sections for conduction between plane, parallel electrodes in rarefied gases, where the mean-free path is much greater than the cathode-anode separation. Expressions are given for the electron ionization efficiency, the ion particle-current density striking the cathode, the power density transferred to the cathode by the ions, and the average impacting ion energy. These expressions are given both for a homogeneous (single species) gas and for a heterogeneous mixture of gases. The latter can be obtained additively from the results obtained by treating each of the constituent gases individually. The maximum impacting ion energy is equivalent to the potential applied across the cathode and the anode; the minimum impacting ion energy is equivalent to the smallest first ionization potential of the gases present in the cathode-anode space. The amount of ionization is discussed in terms of an "ionization volume" swept out by each of the bombarding electrons. By maximizing this volume with respect to the applied potential, the maximum amount of collisional ionization occurs in the cathode-anode space (a potential of approximately 200 V for most gases). Drawings of the typical shape of the ionization volume are given for applied potentials much less than, equal to, and much greater than, the applied potential which yields maximum ionization. A specific example demonstrating an application of the derivations is given, using argon as a model. (auth)

1445 LOW-FREQUENCY INTENSITY OSCILLATIONS OF HELIUM-PLASMA RADIATION AT LOW TEMPERATURES. Reznikov, G. P.; Fugol, I. Ya.; Shevchenko, Yu. F. (Physico-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.), 8: 37-41(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 64-8(July 20, 1968).

While investigating a pulsed hf discharge in a helium plasma, low-frequency oscillations of the radiation intensity were observed. The nature of these oscillations is discussed. (M.O.W.)

1446 DIAGRAM APPROACH TO THE THEORY OF COLLISIONLESS PLASMA TURBULENCE. Biskamp, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch., 23a: 1362-72(Sept. 1968).

From the Vlasov equation written as a nonlinear equation for the distribution function f, a perturbation expansion of the fluctuating part of f, $\tilde{f} = f - \langle f \rangle$, is carried out in terms of the linear solution using a diagram representation similar to that of Wyld. From this a diagram expansion is obtained for the correlation function $U = \langle \tilde{f}\,\tilde{f} \rangle$ and similar diagram series for two auxiliary functions, the averaged linear response function $G = \langle \hat{G} \rangle$ and the generalized vertex function Γ. Approximate asymptotic equations for U imply the summation of appropriate infinite subsets of diagrams. To derive such approximations two criteria are applied: (1) consistency with the basic conservation laws (particle number, momentum, energy); and (2) selection of diagrams analogous to those leading to good approximations in Kraichnan's random oscillator problem, the principal results of which are regained. Contrary to Wyld's summation procedure, diagram summations are not carried out directly in the expansion of U, but in the expansions of the functions $\langle \tilde{f}\,\tilde{f}\,\tilde{f} \rangle$ and $\langle \tilde{f}\,\hat{G} \rangle$, which appear on the right hand side of the differential equations for U and G. This automatically guarantees the validity of the conservation laws. The first approximation discussed, which is equivalent to the quasi-Gaussian approximation well-known from hydrodynamic turbulence, leads to the kinetic wave equation of weak turbulence. The next approximation consists of a coupled set of equations for U and G which are identical with the equations of the symmetrical random coupling model of Orszag and Kraichnan. The third approximation derived implies the generalized vertex function Γ. The first and the third of these approximations cannot be obtained in Wyld's summation scheme. It does not seem possible to derive the third approximation for the nonlinear Vlasov equation using Kraichnan's diagram technic. (auth)

1447 CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES. Tataronis, John Andrew. Stanford Calif., Stanford Univ., 1968. 186p.

A theoretical study is presented of the electrostatic space-charge waves which propagate in a hot plasma immersed in a constant and uniform magnetic field. It is based on the self-consistent solution of the collisionless Boltzmann equation with Poisson's equation in infinite planar geometry and is restricted to interactions which involve only electrons. By considering a series of velocity distributions $f_0(v)$, a clear and comprehensive picture of the propagation characteristics and stability properties of these waves has been obtained. (TSS) (Disser. Abstr.)

1448 QUANTUM MECHANICAL DISTRIBUTION FUNCTIONS FOR AN ELECTRON GAS. Schmitz, G.; Kremp, D. (Univ., Rostock, Ger.). Z. Naturforsch., 23a: 1392-5(Sept. 1968). (In German).

The reduced distribution functions for an electron gas are calculated from the Bogolyubov hierarchy by a perturbation expansion of the density operators with respect to two parameters. The limiting cases $n\lambda^3 \ll 1$ and $n\lambda^3 \gg 1$ are discussed. In the case $n\lambda^3 \gg 1$ the polarization function for small values of the temperature $T \neq 0$ is given. (auth)

1449 EXPERIMENTS ON THE FRESNEL DRAGGING OF 3 cm MICROWAVES BY A LOW-PRESSURE DISCHARGE. Gehre, O.; Mayer, H. M.; Tutter, M. (Institut fuer Plasmaphysik, Munich). Phys. Lett., 28A: 35-6(Oct. 21, 1968).

The Fresnel dragging effect exerted on 3-cm microwaves by the drift of the electron gas in a glow discharge was measured for different electron densities. The discharge tube was surrounded by a circular waveguide. The effect was measured for two excitations corresponding to the H_{11} and E_{01} modes in the empty guide. (auth)

1450 NONLINEAR ELECTRON PLASMA OSCILLATION: THE "WATER BAG MODEL". Bertrand, P.; Feix, M. R. (Univ., Nancy). Phys. Lett., 28A: 68-9(Oct. 21, 1968).

The water bag model for a collisionless electron plasma is strictly equivalent to the hydrodynamic model. The introduction of a stream function and the linearization of the pressure term give a solution valid for small nonlinearity and long wavelength. (auth)

1451 PLASMA PROPERTIES AND OBTENTION OF DENSITIES HIGH ABOVE CRITICAL DENSITY IN RADIO-FREQUENCY PLASMAS. Vandenplas, P. E.; Messiaen, A. M. (Laboratoire de Physique des Plasmas, Brussels). Phys. Lett., 28A: 59-60 (Oct. 21, 1968).

Basic properties of waves in bounded plasmas explain the resonantly sustained behavior of plasma in a magnetic field. The relations between these properties and obtaining of densities high above critical density are investigated. (auth)

1452 PROPAGATION OF ELECTROSTATIC ION WAVES IN THE VICINITY OF ION CYCLOTRON FREQUENCY IN A PLASMA. Sato, T.; Kawabe, T.; Ishii, K.; Otsuka, M.; Takayama, K. (Nagoya Univ., Japan). Phys. Lett., 28A: 52-3(Oct. 21, 1968).

Propagation of electrostatic ion waves excited by means of a grid in the vicinity of the ion cyclotron frequency has strongly dispersive characteristics. (auth)

1453 THE EXPERIMENT OF COLLISION OF TWO PLASMA STREAMS. I. Takeda, Yasumasa; Kawakami, Ichiro (Nihon Univ., Japan). Kakuyugo-Kenkyu, 21: 308-25(Oct. 1968). (In Japanese).

The effective conversion of kinetic energy into thermal energy when two plasma streams collided at the center of a weak magnetic guide was confirmed by comparing the sum of the diamagnetic signals from both single streams with a diamagnetic signal during the collision. The axial distribution of a transverse energy density during the collision was measured by four magnetic loops arranged along the coil axis in the region of the guide field. The axial distribution of the transverse energy density has a maximum at the midplane which increases with the strength of the guide field. It decreases typically from 4×10^{15} to 1×10^{15} eV/cm^3 in 20 μsec and the axial gradient of the transverse energy density becomes slight. The comparison with the axial distribution of kinetic pressure computed by the one-dimensional magnetohydrodynamic code suggests that the thermal conduction along the magnetic field plays a dominant role in the formation of a shock wave. (NSA of Japan)

1454 COLLISION-DOMINATED POSITIVE COLUMN OF A WEAKLY IONIZED GAS. Blank, Joel Lawrence. New Haven, Yale Univ., 1968. 97p.

Thesis.

Despite the fact that the constant coefficient electron diffusion equation for a dilute, collision-dominated, weakly ionized gas is not in general deducible from a systematic analysis of the electron Boltzmann equation, it is extensively employed because of the difficulty in solving the relevant Boltzmann equation. To obtain criteria for the validity of this usage, the well-posed boundary-value problem of the positive column is treated using the Boltzmann equation to govern the behavior of the electrons. The problem is solved completely for the case of a constant electron–neutral recoil collision time for momentum transfer in the limit where inelastic collisions play a weak role in determining the shape of the body of the electron distribution function. Here the bulk of electrons are contained in a space-charge potential well and, except for a thin boundary layer near the wall, it is found that the electron density assumes a Boltzmann distribution, and the electron temperature and diffusion coefficient are constant. It is established that, unless the electron energy relaxation length is small compared with the macroscopic length scale, these results are correct only if the following conditions exist: the recoil collision time is reasonably constant over the domain which makes the major contribution to the velocity space moments of the electron distribution function; and the electron fluxes in configuration and velocity spaces are appropriately small. The general method of solution is suitable for application to diffusive phenomena involving weakly ionized gases whenever these conditions are satisfied. The electron boundary layer is treated systematically in accordance with the method of matched asymptotic expansions. A detailed analysis for the case of a quasi-neutral positive column is presented and the proper form of the ambipolar diffusion coefficient is determined. The quasi-neutrality approximation fails near the wall where a space-charge sheath exists. An inner–outer expansion technique is employed to obtain a self-consistent solution. (Disser. Abstr.)

1455 ELECTROMAGNETIC WAVE PROPAGATION NEAR THE HYBRID ION–ELECTRON RESONANT FREQUENCY IN A CONTACT CESIUM PLASMA. Breihan III, Bernard Edward. Austin, Tex., Univ. of Texas, 1967. 141p.

Thesis.

Experimental studies of electromagnetic wave propagation were carried out in a contact cesium plasma with particular interest centered on propagation near the hybrid ion–electron resonant frequency. Existing studies of this resonance have been confined to nonlinear experiments in hydrogen, deuterium, and helium plasmas. In contrast, the results from a linear experiment utilizing a low-power Q meter for the probing signal, thus ensuring small-amplitude perturbation, were carried out in a cesium plasma produced by contact ionization. The results are compared with a theoretical treatment which includes finite plasma effects, in particular, the plasma length, the coil length, and the gap between the coil and plasma. This treatment predicts various extrema in the loading resistance of the plasma which can be classified as either intrinsic resonances which are found on the basis of an infinite plasma analysis or "geometrical coupling resonances" which are associated with the finite dimensions of the plasma. In previous experiments in hydrogen, deuterium, and helium, there is very little frequency separation of the two intrinsic resonances. In the cesium plasma, the experimental configura-

tion is such that these intrinsic resonances have a large frequency separation. The higher-frequency resonance is studied and the importance of the finite plasma effects in providing good agreement between theory and experiment is detailed. (Disser. Abstr.)

1456 DRESSED PARTICLES: MODEL IN MICROFIELD THEORY. Gunter, Ecker; Fischer, Klaus-Gotthard (Ruhr-Univ., Bochum, Ger.). Forschungsber. Landes Nordrhein-Westfalen, No. 1949, 3-33(1968). (In German).

The applicability of the dressed-particle models to the detection of the internal interaction in the microfield theory is investigated. From the known definition of the low-frequency components of the microfield distribution, it is shown that the mean potential in the configuration of the N_i ions is represented as the sum of effective pair potentials and the mean field effect is represented as the sum of effective pair field effects of the Debye type. A critical analysis of the current microfield theories served as the basis for the testing of the dressed-particle models proposed. The inadequacy of the Baranger–Mozer model in the higher approximations is shown. The calculations of the Alyamovskii model summarize the internal interaction of the system in a plasma-dipole distribution, whose form was not derived but only postulated previously. The corresponding pair distribution functions were derived in the present study by use of diagram-technique methods. The Baranger–Mozer model is considered the best approximation at the present, and this is confirmed by a numerical comparison for uncorrelated dressed ions. (J.S.R.)

1457 EXCITATION OF ION OSCILLATIONS BY BEAM-PLASMA INTERACTION. Vermeet, Abraham. Delft, Netherlands, Technische Hogeschool, 1968. 119p.

Thesis.

A thin electron beam was injected into a tube filled with a low-pressure gas. The frequency spectrum of the measured instabilities are divided into categories of lf and hf oscillations. The experiment is described in detail. (M.O.W.)

1458 DIFFRACTION OF THE CYLINDRICAL WAVE BY THE IDEAL-CONDUCTING WEDGE IN ANISOTROPIC PLASMA. Bobrovnikov, M. S. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 19-30(1968). (In Russian).

Problems on the diffraction of cylindrical waves on ideal conducting wedges in anisotropic plasma were formulated and resolved. The integral equations for the field were reduced to function equations, which were solved by means of special functions introduced. The properties of these functions were investigated. The general solution is presented in the form of binary contour integrals in the density of the complex variables. An analysis was made of the radiation field and the wave surface for a series of cases. The diffraction on the semi-plane was investigated. (tr-auth)

1459 STUDY ON THE θ-PINCH SHOCK-WAVE TUBE. Kasahara, Eizi; Miida, Atsuro (Keio Univ., Japan). Nippon Kikai Gakkai Rombunshu, 33: 1977-83(Dec. 1967). (In Japanese).

A θ-pinch shock tube was constructed, and the behavior of shock waves occurring in the tube and, also, the characteristics of the tube were studied experimentally. With $P_0 = 0.01$ to 0.3 mm Hg, $V_0 = 8$ to 30 kV, and $C_0 = 2$ to 10 μF, the following were observed: (1) the shock waves occurring in the tube are proportional with $(V_0^2/P_0)^{1/4}$, and the characteristic expression is $U = 0.22\ (V_0^2/P_0)^{1/4}$ cm/μs (10^4V, mmHg); (2) the velocity of the shock waves is independent of the capacity of the energy-source condenser, but the attenuation of their velocities becomes smaller as the capacity is increased; (3) in the place of discharge, the phenomenon of an ionization before the pinch contraction agrees nearly with Townsend's theory; and (4) from the above, the mechanism of the occurrence in the tube is: the ionized gas produced by the change of magnetic field in the coil receives a pinch contraction, then, the gas at the position of discharge is heated by the shock waves in the front, and subsequently, it takes the form of a pinch expansion. (NSA of Japan)

1460 INFLUENCE OF STRESS TENSOR ON INSTABILITY OF ALFVEN WAVES IN NONHOMOGENEOUS WAVE MEDIA. Grebinskii, A. S. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 10, 35-40(May 1968). (In Russian).

The stress tensor of magnetohydrodynamics is shown to have nondissipative components, proportional to the product of wave magnetic field and gradient velocity of medium. The detection of the Alfvén waves is possible on condition that: $\omega_i\tau_i \gg 1$, $nT \gg (H_0^2/8\pi)$ and great gradient of the velocities of medium. (auth)

1461 LONGITUDINAL WAVES IN A PLASMA HALF-SPACE. Black, W. M.; Klevans, E. H. (Pennsylvania State Univ., Philadelphia). Nuovo Cim., 57B: 271-96(Oct. 11, 1968).

The electric field in a plasma half-space is determined using a normal mode analysis with collisions considered using a BGK particle-conserving collision model. For the collisionless case, the results are shown to be equivalent to the results of Landau who used transform methods. For distances greater than five Debye lengths from the boundary, and for collision frequencies up to 0.01 ω_p, it is shown that collisions have little effect on the electric field except in the frequency range $0.95\ \omega_p < \omega < 1.2\ \omega_p$. Within this frequency band, collisons produce different kinds of effects, depending upon the frequency of the applied field and upon the collision frequency. For most of the frequencies, the field is damped more rapidly with distance. For special frequencies, however, collisions destroy the collisionless damping and reduce the total damping. (auth)

1462 REFLECTION AND TRANSMISSION OF NORMALLY INCIDENT WAVES BY A SEMI-INFINITE LONGITUDINALLY DRIFTING MAGNETOPLASMA. Chawla, B. R.; Unz, H. (Univ. of Kansas, Lawrence). Nuovo Cim., 57B: 399-422(Oct. 11, 1968).

Normal incidence of linearly polarized electromagnetic waves on a semi-infinite longitudinally drifting, homogeneous, temperate magnetoplasma, where the static magnetic field is in the longitudinal direction, is considered. The reflected and transmitted waves from the drifting boundary of the magnetoplasma are calculated and both relativistic and nonrelativistic solutions are presented. It has been found that both solutions give identical results for the present case. (auth)

1463 PULSED MOVING PLASMA REFLECTION FROM METALLIC SURFACE. Chutov, Yu. I. (Kiev State Univ.). Ukr. Fiz. Zh., 13: 1037-40(June 1968). (In Russian).

A nickel cylinder whose end face served as a solid barrier for plasma flow was attached to the walls of a cylindrical electrical-discharge shock tube 16 mm in diameter. At a distance of 7 cm from the discharge part of the tube, a cylindrical probe of tungsten wire 100 μ in diameter was inserted. The tube was filled with argon at 0.5 mm pressure. The change in the intensity of the spectral argon emission with time was determined at 4800 Å at different points along the tube axis. With the solid barrier at a large distance from the discharge tube, a single emission peak was noted, but two peaks were observed with the barrier at a distance of 10 cm from the end of the discharge tube. The propagation rates of the secondary peaks were found to be 2×10^5 and 1.4×10^5 cm/sec at propagation rates of 3.0×10^5 and 2.1×10^5 cm/sec respectively for the primary plasma. Since an increase in electron temperature was detected with another problem, it is concluded that the reflected wave interacted with the incident wave. (TTT)

1464 MAGNETIC FIELD EFFECTS ON LANDAU DAMPING. Babler, Gary Michel. Columbia, Mo., Univ. of Missouri, 1968. 186p.

An investigation was made to study the effects of an external magnetic field on Landau damping of longitudinal electron oscillations in a nonrelativistic boundless, Maxwellian, collisionless magnetoplasma in a formalism which allows subsequent investigation of the coupling effects between the longitudinal and transverse waves. Throughout the entire investigation the initial perturbation was assumed to be analytic: sinusoidal in space and Maxwellian in velocity. (TSS) (Diss. Abstr.)

1465 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF MAGNETICALLY BALANCED ARCS. Harvey, Robert Laurie. Ann Arbor, Mich., Univ. of Michigan, 1968. 162p.

An investigation of electric arcs balanced magnetically in transverse air flows was conducted. The purpose was to determine the fluid dynamic structure of the stable positive column interacting with the free stream. The experimental work was in a Mach number range of 2.5 to 3.5, with stagnation pressures of 10 to 29 in. Hg. Arc currents were from 130 to 700 amperes with the arc balanced by an external magnetic field up to 3000 gauss in strength. Measurements of the optical shape of the balanced column showed little variation near the upstream boundary when the exposure was varied by a factor of ten and little variation near the downstream boundary when the exposure was varied by a factor of three. A mathematical model for the internal flow based upon the experimental work is formulated and solved numerically. The resulting flow pattern has a doublet-like flow structure with the maximum temperature peak shifted in the Lorentz direction. It is concluded that the boundary temperature and induced electric field are important factors affecting the internal flow, while compressibility is less significant. (TSS) (Diss. Abstr.)

1466 ELECTRODE HEAT TRANSFER STUDY IN A MAGNETO-PLASMA-DYNAMIC ARC. Shih, Kwang-tien. Minneapolis, Univ. of Minnesota, 1968. 104p.

Experiments are performed to measure the electrode heat transfer of a magneto-plasma-dynamic (MPD) arc. Two different axially symmetric anode configurations are used: a solid cylindrical anode for the measurements of total quantities, and a longitudinally seg-

mented anode for "local" measurements. Experimental versions of MPD arc thrustors have been operated in a low-pressure environment maintained in a water-cooled vacuum chamber. Argon and ammonia are used as working fluids over a range of arc currents, mass flow rates, chamber pressures and magnetic field strengths. A simple anode heat transfer model is proposed and confirmed by the experimental data, which show that there is a linear relationship between the anode heat fluxes and the arc current. The contributions of the various modes of anode heat transfer, which are heat transfer by convection and radiation, and heat transfer by electrons, are determined. With increasing mass flow rate a transition from laminar to turbulent flow seems to occur as indicated by the appearance of the plasma plume emanation from the anode orifice. This transition has a severe influence on the observed anode heat fluxes, especially at low pressure levels. A slight increase of the anode heat fluxes is observed with increasing magnetic field strength. (Diss. Abstr.)

1467 NONEXISTENCE OF LOOPING TRAJECTORIES IN HYDROMAGNETIC WAVES OF FINITE AMPLITUDE; BREAKING OF WAVES IN A COLD COLLISION-FREE PLASMA IN A MAGNETIC FIELD; AND STABILITIES OF PERIODIC WAVES IN COLD COLLISION-FREE PLASMA IN MAGNETIC FIELD. Yeh, Tyan. Pasadena, Calif., California Inst. of Tech., 1968. 99p.

This dissertation consists of three parts. In Part I, it is shown that looping trajectories cannot exist in finite amplitude stationary hydromagnetic waves propagating across a magnetic field in a quasi-neutral cold collision-free plasma. In Part II, time-dependent solutions in series expansion are presented for the magnetic piston problem, which describes waves propagating into a quasi-neutral cold collision-free plasma, ensuing from magnetic disturbances on the boundary of the plasma. The expansion is equivalent to Picard's successive approximations. It is then shown that orbit crossings of plasma particles occur on the boundary for strong disturbances and inside the plasma for weak disturbances. In Part III, the existence of periodic waves propagating at an arbitrary angle to the magnetic field in a plasma is demonstrated by Stokes expansions in amplitude. Then stability analysis is made for such periodic waves with respect to side-band frequency disturbances. It is shown that waves of slow mode are unstable whereas waves of fast mode are stable if the frequency is below the cutoff frequency. The cutoff frequency depends on the propagation angle. For longitudinal propagation the cutoff frequency is equal to one-fourth of the electron's gyrofrequency. For transverse propagation the cutoff frequency is so high that waves of all frequencies are stable. (Diss. Abstr.)

1468 TWO-DIMENSIONAL EQUILIBRIUM FOR HIGH-β MIRROR DEVICES INCLUDING PARTICLE LOSS. Friedberg, J. P.; Grossmann, W. (New York Univ., N. Y.) Phys. Fluids, 11: 2476-85(Nov. 1968).

Two-dimensional equilibria for high-β mirror devices are found by solving the Vlasov equation and Ampere's law self-consistently. Particle loss is taken into account self-consistently by allowing particles to exist only outside of the local loss-cone angle. It is found that for a given set of plasma parameters and applied mirror ratio (1) solutions only exist below some critical value of β, and (2) in certain cases the solutions show a nonuniqueness related to the question of stability. (auth)

1469 CALCULATIONS OF TWO-DIMENSIONAL PLASMA FLOW IN COAXIAL CHANNELS. Brushlinskii, K. V. Zh. Vychisl. Mat. i Mat. Fiz., 8: 1039-48(Sept.-Oct. 1968). (In Russian).

A mathematical problem was set up for two-dimensional flow of completely ionized plasma in coaxial channels and calculation methods are described for approximate solution of the problem. The problem is formulated as a system of differential equations numerically resolved and complete list is given of characteristics for dimensionless parameters determining each flow variation. (R.V.J.)

1470 MODIFIED ORDINARY MODE IN MAGNETIZED PLASMAS WITH RELATIVE STREAMING. Lee, Kai Fong (National Center for Atmospheric Research, Boulder, Colo.). Phys. Rev. Lett., 21: 1439-41(Nov. 11, 1968).

It is shown that in the presence of relative streaming motion, linearly polarized electromagnetic waves of frequencies below the plasma frequency can propagate across the magnetic field. An instability criterion is given for this "modified ordinary mode." (auth)

1471 IONIZING SHOCK STRUCTURE IN A MONATOMIC GAS. Chubb, Donald L. (Columbia Univ., New York). Phys. Fluids, 11: 2363-76(Nov. 1968).

The structure of an ionizing shock front in a monatomic gas is described. Both atom–atom and electron–atom collisional ionization are considered. The ionization rates for either of these processes is assumed to be controlled by the rate of excitation from the ground state to the first excited level. In the front part of the shock, called the atom–atom shock, atom collisional dissipative mechanisms (viscosity and thermal conductivity) determine the shock structure. A bimodal Mott–Smith velocity distribution function is assumed for the atoms in this region, which has a thickness of the order of the atom–atom viscosity mean free path. In the rear part of the shock front, called the relaxation zone, the collisional ionization processes determine the structure. For this region, which has a thickness proportional to the electron–atom ionization mean free path, Maxwellian velocity distributions are assumed for the electrons, ions, and atoms. It was found that for Mach numbers of 30 or more the atom–atom shock is of comparable thickness to the relaxation zone and the degree of ionization behind the atom–atom shock is the order of 10^{-1}. (auth)

1472 DECAY OF NEUTRAL WAVE INTO ION WAVES. Ohnuma, Toshiro; Hatta, Yoshisuke (Tohoku Univ., Sendai). Phys. Fluids, 11: 2500-1(Nov. 1968).

Neutral wave with large amplitude is treated against the decay into two ion–acoustic waves in a weakly ionized plasma. (auth)

1473 ENHANCED BREMSSTRAHLUNG FROM SUPRALUMINOUS, AND SUBLUMINOUS, WAVES IN AN ISOTROPIC, HOMOGENEOUS PLASMA. Lerche, I. (Univ. of Chicago). Phys. Fluids, 11: 2459-71(Nov. 1968).

A calculation is presented of the bremsstrahlung radiation from a thermal, Maxwellian electron plasma which may have an isotropic, relativistic, (non-Maxwellian) tail. The calculation assumes homogeneity, isotropy, the absence of any imbedded ambient magnetic fields, and a smeared out distribution of ions which serves to preserve over-all space charge neutrality, but does not take part in any motion. When allowance is made for the fact that no particles resonate with waves whose phase velocity exceeds the speed of light, it is demonstrated that the "character" of the emission changes sharply at $\omega = ck$. Provided the electron temperature is less than about 10^8 °K, it is shown that the supraluminous ($\omega > ck$) bremsstrahlung from the thermal electrons dominates the subluminous ($\omega < ck$) radiation from the same particles. It is also shown that a few relativistic electrons can act as a "catalyst," greatly enhancing the subluminous bremsstrahlung but hardly influencing the supraluminous bremsstrahlung. The enhanced emission occurs at, and at twice, the electron plasma frequency. Using numerical values appropriate to the Crab nebula, it is shown that the enhanced subluminous bremsstrahlung can easily dominate the synchrotron radiation and the usual "collisional" bremsstrahlung at, and at twice, the electron plasma frequency. Also the enhanced supraluminous emission due to static "bumps" in the plasma is shown to exceed other conventional radiation processes in the Crab nebula. (auth)

1474 DIPOLE AND QUADRUPOLE BREMSSTRAHLUNG AND THE DAMPING OF ELECTRON PLASMA OSCILLATIONS FOR ANY DEGREE OF IONIZATION. Shkarofsky, I. P. (RCA Victor Research Labs., Montreal). Phys. Fluids, 11: 2454-8(Nov. 1968).

Electron–ion, electron–neutral dipole, and k^2 radiations and electron–electron quadrupole k^2 radiation are obtained from a calculation of current with quadratic gradient terms and agree with other derivations. The collisional time damping of electron plasma oscillations is also evaluated, and agrees with parts of other papers in the literature. A negative k^2 collisional electron–ion contribution is found which disagrees with other analyses and computer experiments. (auth)

1475 SIMULTANEOUS MEASUREMENTS OF ION–ACOUSTIC-WAVE POTENTIAL AND PLASMA DENSITY PERTURBATION TO YIELD γ_e. Doucet, H. (Ecole Polytechnique, Paris); Alexeff, I.; Jones, W. D. Phys. Fluids, 11: 2451-3(Nov. 1968).

Simultaneous measurements of ion–acoustic-wave potential and accompanying plasma density perturbation show that the two ratios, eV_1/kT_e and n_1/n_0, which are related theoretically by γ_e, are $\ll 1$ and are equal within the limits of experimental error. Thus, these waves are highly linear and γ_e is experimentally equal to 1. (auth)

1476 GEODESIC ACOUSTIC WAVES IN HYDROMAGNETIC SYSTEMS. Winsor, Niels; Johnson, John L.; Dawson, John M. (Princeton Univ., N. J.). Phys. Fluids, 11: 2448-50(Nov. 1968).

In toroidal systems with geodesic curvature an electrostatic acoustic mode occurs with plasma motion in the magnetic surfaces, perpendicular to the field. In typical stellarators this mode should dominate ordinary sound waves associated with motion along the field. (auth)

1477 WAVE MIXING IN A BOUNDED MAGNETOPLASMA. Kuhn, Lawrence; Lehany, R. F.; Marshall, T. C. (Columbia Univ., New York). Phys. Fluids, 11: 2440-8(Nov. 1968).

Generation of space-charge waves at ultrahigh frequencies by the nonlinear interaction of two microwave signals in a magneto-plasma is described. The experiment was performed using a neon afterglow ($p = 2 \times 10^{-2}$ torr), which formed a post in a square X-band waveguide. The results of the experiment agree quantitatively with a calculation of the interaction which accounts for its finite geometry. The nonlinear coupling is found to result from a Lorentz force interaction between the electron velocity induced by one incident wave and the time varying a magnetic field of the other. A similar calculation and experiment were performed in which one microwave signal was scattered from a driven space-charge wave. The mechanism for this coupling is found to be an ñev type nonlinearity. It is shown that the results of the two first-order interactions can be combined to give a realistic prediction of a second-order process such as "optical mixing." (auth)

1478 COLLISIONAL DRIFT WAVES: IDENTIFICATION, STABILIZATION, AND ENHANCED PLASMA TRANSPORT. Hendel, H. W.; Chu, T. K.; Politzer, P. A. (Princeton Univ., N. J.). Phys. Fluids, 11: 2426-39(Nov. 1968).

Density-gradient-driven collisional drift waves are identified by the dependences of ω and k on density, temperature, magnetic field, and ion mass, and by comparisons with a linear theory which includes resistivity and viscosity. Abrupt stabilization of azimuthal modes is observed when the stabilizing ion diffusion over the transverse wavelength due to the combined effects of ion Larmor radius and ion-ion collisions (viscosity) balances the destabilizing electron-fluid expansion over the parallel wavelength, determined by electron-ion collisions (resistivity). The finite-amplitude ($\tilde{n}/n_0 \simeq 10\%$) coherent oscillation, involving the entire plasma body, shows a phase difference between density and potential waves (which is predicted by linear theory for growing perturbations). The wave-induced radial transport exceeds classical diffusion, but is below the Bohm value by an order of magnitude. Although observations have been extended to magnetic fields three times those for drift-wave onset, turbulence has not been encountered. (auth)

1479 EFFECT OF COULOMB COLLISIONS AND MICRO-TURBULENCE ON THE PLASMA WAVE ECHO. O'Neil, Thomas M. (Univ. of California, San Diego, La Jolla). Phys. Fluids, 11: 2420-5(Nov. 1968).

The effect of Coulomb collisions and microturbulence on the recently discovered plasma wave echo is considered. The echo depends on perturbations in the particle distribution which are rapidly oscillating functions of velocity. Coulomb collisions and microturbulence, which consist of many small angle collisions, are particularly effective at smoothing out such perturbations and therefore, at destroying the plasma wave echo. It is shown that in the limit of heavy damping, Coulomb collisions make a second-order electron wave echo sharper, damping the wings of the echo more than the peak. It is also shown that a third-order echo may be used as a tool to experimentally evaluate the velocity dependence of the coefficient of the second velocity derivative in the Fokker-Planck operator. For the case where this coefficient is due to microturbulence one could check the well-known statement of quasilinear theory that this coefficient is just the spectral density of the turbulence. (auth)

1480 STABILITIES OF PERIODIC WAVES IN A COLD COLLISION-FREE PLASMA IN A MAGNETIC FIELD. Yeh, Tyan (California Inst. of Tech., Pasadena). Phys. Fluids, 11: 2406-19(Nov. 1968).

The existence of periodic waves propagating at an arbitrary angle to the magnetic field in a plasma is demonstrated by Stokes expansions in amplitude. Stability analysis is then made for such periodic waves with respect to side-band frequency disturbances. It is shown that waves of slow mode are unstable whereas waves of fast mode are stable if the frequency is below the cutoff frequency. The cutoff frequency depends on the propagation angle. For longitudinal propagation, the cutoff frequency is equal to one-fourth of the gyrofrequency of the electron. For transverse propagation, the cutoff frequency is so high that waves of all frequencies are stable. (auth)

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1481 (AD-670838) STUDY OF THE INITIAL IONIZATION PROCESS IN A STRONG SHOCK WAVE. Belozerov, A. N. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). June 1968. 90p. (UTIAS-131; AFOSR-68-0828). CFSTI.

A theoretical and experimental investigation was made of the initial ionization processes in a strong shock wave in hydrogen. The relaxation length for ionization, which is principally determined by the rate of excitation, was measured and from a comparison with the theory an estimate was obtained for the cross section for atom-atom excitation collisions. Detailed theoretical calculations showed that the electron temperature approaches to within a few percent of the atom temperature in a distance that is small compared to the total relaxation length for ionization. This enabled considerable simplification for it indicated that a single-temperature model could be used in calculating the theoretical relaxation profile over the experimental range of operating conditions. An electromagnetic shock tube, with a Philippov pinch to create the driver plasma, was employed to produce shock waves of the required velocity. The ionization behind the shock front was studied by means of a double frequency Mach-Zehnder interferometer, with a ruby laser and a KDP crystal (a second harmonic generating crystal) and the light source. A close agreement between the theoretical and experimental electron density profiles behind the shock front, was obtained for small relaxation lengths, when the cross section for the atom-atom excitation collisions was assumed to be about .021 times that of the corresponding electron-atom excitation collision. For larger relaxation distances which correspond to shock speeds less than 3.3×10^6 cm/sec it was necessary to introduce corrections for blast wave effects in order to get good agreement with experiment for the same value of cross section. (auth) (USGRDR)

1482 (AD-671979) A STEADY STATE PLASMA FACILITY. Leonard, Stanley L. (Aerospace Corp., El Segundo, Calif.). Mar. 1968. Contract F04695-67-C-0158. 55p. (TR-0158(3220-20)-1; SAMSO-TR-68-234). CFSTI.

A facility is described in which a magnetically confined column of highly ionized argon or helium plasma is produced. The primary plasma is generated in a hollow-cathode arc and diffuses along a magnetic field through a region where neutral particles are preferentially removed. Detailed Langmuir probe measurements were carried out in the argon plasma. Spectroscopic observations have included measurements of absolute continuum intensity, relative intensities of lines emitted by a given species (e.g., He I, Ar II), and ratios of the intensities of lines emitted in successive ionization stages of the same atom. From the probe and spectral measurements the peak electron temperature in argon is found to be 3.0 eV, while the peak electron number density is 5×10^{13} cm^{-3}. The corresponding numbers for helium are 4 eV and (10^{14} cm^{-3}). Relative intensity measurements of He I and He II lines appear to be strongly influenced by the influx into the plasma column of background neutral particles whose mean free path is long compared to the diameter of the plasma column. (auth) (USGRDR)

1483 (N-68-25877) GENERAL OPERATING CHARACTERISTICS OF A BACK STREAMING DIRECT-CURRENT PLASMA GENERATOR. Krawec, Roman (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1968. 26p. (NASA-TM-D-4604). CFSTI.

Experimental studies were performed on a plasma generator consisting of a filament and a hollow, gas-fed anode which were immersed in an axial magnetic field. The hydrogen plasma formed between the filament and anode was allowed to diffuse past the filament, through a transition section, and into a low-pressure test section. The plasma within the test section was characterized by having two groups of electrons which differed in temperature and had a peak density greater than 2×10^{12} centimeter^{-3}. The no-plasma background pressure within the test chamber was an order of magnitude less than the peak electron density. Evidence was found indicating that thermal dissociation of the hydrogen molecule occurred within the hollow anode. (auth) (STAR)

1484 (NP-tr-1696) LASERS IN PHYSICAL INVESTIGATIONS. Basov, N. G. Translated for Culham Lab., Abingdon, Eng., from Priroda, 57: No. 10, 17-23(Oct. 1967). 13p. (CTO-517). Dep. CFSTI. UK.

The application of lasers to the generation and heating of plasma is discussed. The properties of a plasma produced by the action of a laser pulse on a carbon target in a vacuum were studied; measurements of electron density using interferometry and measurements of the square of the plasma propagation velocity are reported. (D.L.C.)

1485 OPERATION OF A SINGLE-ELECTRODE COAXIAL PLASMA GUN. Pert, G. J. (Univ. of Alberta, Edmonton). Can. J. Phys., 46: 2055-8(Sept. 15, 1968).

The operation of a coaxial-type plasma gun with the central electrode replaced by a pinched gas column was studied by high-speed photography and magnetic probes. It was found that the discharge was unstable after approximately 1.5 μsec and that the plasma slug was not accelerated by the current after this time. Parametric studies indicated that the plasma slug was contaminated with impurities from the insulating back wall of the device. (auth)

1486 RETRACTING PEDESTAL APPARATUS THAT PRESENTS A SINGLE SOLID TARGET TO A FOCUSED Q-SWITCHED

LASER BEAM. Pack, John L.; George, T. V.; Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh). Rev. Sci. Instrum., 39: 1697-1700(Nov. 1968).

An electromechanically operated retracting pedestal system has been developed for injection of a single solid target as small as a few tens of microns in radius into a vacuum system. After the pedestal has withdrawn completely from the system, the falling target, which originally was positioned on top of the pedestal, is ionized by a focused, high power, Q-switched laser beam. Since the plasma is produced in a relatively large volume free of mechanical obstructions, it can be easily studied or used as a source of ions. The pedestal is withdrawn with a velocity in excess of 10 m-sec^{-1}, whereas the target falls with a velocity given solely by the acceleration due to gravity. The laser beam which ionizes the target is triggered by an optical tracking system, consisting principally of an He–Ne laser whose beam is collinear with that of the pulsed laser. The device can be loaded rapidly in vacuum from a reservoir with a capacity of hundreds of targets, and fired every few minutes. Application to experiments on laser-created plasmas is discussed. (auth)

1487 PRODUCTION OF A DENSE THERMONUCLEAR PLASMA BY A PULSED HIGH INTENSITY FIELD EMISSION DISCHARGE. Winterberg, F. (International Centre for Theoretical Physics, Trieste, Italy). Z. Naturforsch., 23a: 1396-7 (Sept. 1968).

A new method to controlled fusion is proposed which is based on a recently developed technique to produce very intense and energetic electron beams for a period on the order of a few nanoseconds. The energy for the pulsed field emission discharge is drawn from a large capacitor bank by means of the Marx circuit technique. The electrons are extracted from a concave brush of field emitter cathodes. If their space charge is neutralized by a plasma, then the electrons can be collimated into a narrow beam because of their high self-magnetic field. The neutralizing plasma can be generated by the evaporation of the target surface. For the same purpose one can place a tenuous plasma in front of the target. The apparatus is discussed. (M.O.W.)

1488 SUITABLE TARGETS FOR THE PRODUCTION OF A DEUTERIUM PLASMA CLOUD IN A VACUUM ENVIRONMENT WITH A LASER PULSE. Cecchini, A.; De Angelis, A.; Gratton, R.; Parlange, F. (Associazione EURATOM–CNEN, Rome). J. Phys., E, (London), 1: 1040-2(Oct. 1968).

A device is described for the injection of small deuterium specks (volume ~10^{-5} cm^3) into a vacuum region, where they are ionized by a giant pulse delivered by a Q-switched neodymium laser. The specks are injected in such a way that a reasonably high percentage of them cross the laser focal spot region. The performance of the device is reported. (auth) (UK)

1489 PLASMA PRODUCTION SYSTEM FROM A SINGLE SOLIDIFIED GAS PARTICLE BY MEANS OF GIANT LASER. Hirosawa, Haruto; Tanimoto, Mitsumori (Tokyo Univ.). Kakuyugo-Kenkyu, 21: 86-101(July 1968). (In Japanese).

Gases (CO, Xe, and H) were contained in a column 0.4 mm in diameter and about 0.7-mm long. The column is thinned at the base as a result of gradual evaporation and is cut by a low-power laser pulse or by an edge driven mechanically. The light signal scattered from the falling column triggers a Q-switched laser (100 MW). The laser light pulse is focused on a particle isolated at the center of a vacuum chamber to produce high-temperature and high-density plasma. Such plasma will contribute to the fundamental research of plasma physics. (NSA of Japan)

1490 MECHANISM OF POPULATING THE EXCITED STATES OF NEUTRAL HELIUM ATOMS IN A DISCHARGE WITH OSCILLATING ELECTRONS. Romanov, N. P. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 468-71(June 1968).

Translated from Opt. Spektrosk., 24: 873-8(June 1968).

The populations of the excited states of neutral atoms in helium plasma with an electron concentration $n_e = 10^{14}$ cm^{-3} and electron temperature $T_e = 10$ eV were measured. There is a rapid decrease of population with the increase of the principal quantum number n. The distribution of populations of the levels with the same n does not correspond to the statistical weights. The mechanism of populating the excited states which explains the observed population is discussed. On the basis of this consideration, the concentration of neutral atoms is estimated to 4×10^{13} cm^{-3}. (auth)

1491 AMPLIFICATION OF CURRENT AND RADIATION INTENSITIES IN THE NEGATIVE GLOW PLASMA OF A HOLLOW CATHODE DISCHARGE IN MAGNETIC FIELD. Badareu, Eugen; Popovici, Constantin; Somesan, Maria. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 245-8(Feb. 1968).

The results obtained concerning current and radiation amplifications in the negative glow of a hollow-cathode discharge in a magnetic field seem to be explained by assuming only a change of the distribution function of electron velocities during the effect. Such an alteration of the velocity distribution curve is physically justified if the hollow cathode effects are regarded as a manifestation of the growth of plasma–beam instabilities in the cathode cavity in certain conditions. (M.H.R.)

Stability

1492 (LA-3990, pp B1,1-4) NUMERICAL INVESTIGATION OF THE TWO-STREAM INSTABILITY VIA HAMILTON'S PRINCIPLE. Lewis, H. Ralph; Melendez, K. J. (Los Alamos Scientific Lab., N. Mex.).

A new numerical method is being used to investigate the instability of two cold streams in a periodic, one-dimensional plasma consisting of a single species with a fixed neutralizing background. The plasma is treated in the Vlasov approximation, and the starting equations are Poisson's equation and the equation of motion that determines the trajectory of each of the infinite number of particles present in one spatial period of the plasma. The solution of the particle equation of motion is represented approximately by a linear combination of a finite number of basis functions of the initial position and velocity of the particle with time-dependent coefficients. Similarly, the scalar potential is represented approximately by a linear combination of a finite number of basis functions of position with time-dependent coefficients. The quantities to be determined are the time-dependent coefficients. The equations governing the time evolution of these coefficients are determined uniquely and directly from Hamilton's principle, and they are solved numerically by a standard technique for which numerical stability is guaranteed. Preliminary results will be presented. (auth)

1493 (LA-3990, pp D3,1-5) REDUCED SPACE MODELS FOR COMPUTER SIMULATION OF PLASMA MICROINSTABILITIES. Byers, J. A.; Grewal, M. (California Univ., Livermore. Lawrence Radiation Lab.).

Arbitrary restriction of the spatial configuration to less than three dimension allows one to focus the resolving power of the computer on the details of the velocity distribution. This technique, first developed in one dimension by Hasegawa and Okuds, allows one to examine complicated problems that involve both gyro motion perpendicular to the magnetic field, B, and also motion along B. The technique is to simply restrict the wave vector, k, to less than three dimensions and demand exact uniformity of all quantities in the direction(s) perpendicular to the allowed k. One thus transforms the particles into sheets for one-dimensional models, and into rods for two-dimensional models. The full three-dimensional model is applied to an infinite medium $k_{||} = 0$ mode, where the instability arises due to the monoenergetic perpendicular velocity distribution. The instability can be clearly observed above the fluctuation noise, and growth to saturation is very rapid, occurring in approximately 5–10 ω_{ci}^{-1}, roughly consistent with the linear theory. The maximum attainable electric field energy is only approximately 5% of the plasma kinetic energy. The velocity distribution spreads very rapidly into a state which is stable according to linear theory, but long-time wave fluctuation effects persist. (auth)

1494 (MIAPH-PL-68,5) THE ONSET OF THE HELICAL INSTABILITY IN WEAKLY IONIZED DISCHARGE PLASMAS. Plasma Physics Bulletin, Vol. 8, No. 2. Robertson, Harry S.; Currie, Edward H. (Miami Univ., Coral Gables, Fla. Dept. of Physics). June 1968. 10p. Dep. CFSTI.

The helical instability in a discharge plasma has been variously reported, sometimes as having an explosive onset, sometimes as reversible. It was found experimentally that in cesium arc plasmas, the onset is always explosive provided the ambient noise level is low enough; hysteresis is normally present; and plasma parameters change discontinuously at the onset and extinguishment of the instability. In the presence of noise, however, one finds the onset to be reversible and continuous. (auth)

1495 (N-68-29902) ONSET AND SUPPRESSION OF PLASMA INSTABILITY IN CROSSED-FIELD GEOMETRY. Sidney, B. D.; Hess, R. V.; Allario, F. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1968]. 18p. (NASA-TM-X-61021; CONF-680630-2). CFSTI.

From American Physical Society Meeting on Plasma Physics, Fluid Dynamics, Electron and Atomic Physics, Los Alamos, N. Mex.

A linear Hall accelerator with axial and azimuthal probe wires was prepared to investigate the relation between low-frequency azimuthal rotating plasma instability onset and a critical magnetic field in a crossed-field geometry. Measurements were made of the

floating potential and ion saturation current in argon, xenon, helium, and nitrogen with an arc current of 2.5 A and using a spectrum analyzer or dual-beam oscilloscope. Effects resulting from the magnetic field generated by the cathode current and configuration showed that the instability onset is determined by a critical value of the radial magnetic field, that the cathode region is the origin of the instability, and that it may be suppressed in the interelectrode region by controlling the radial magnetic field near the cathode only. Introduction of an axial component of the same order of the radial component required for onset had no effect on instability onset. A supplementary observation shows that a low-frequency rotating instability, exhibiting abrupt onset at a critical magnetic field which depends on arc current, has been detected in the exhaust jet and interelectrode region of a moderately high-power MPD arc thruster using argon and an arc power of between 10 and 25 kW. (STAR)

1496 (TID–24759) PLASMA INSTABILITIES. Harris, Edward G. (Tennessee Univ., Knoxville). [1968]. 82p. Dep. CFSTI.

Lectures on the various types of macroscopic and microscopic instabilities are presented. Nonlinear effects are also discussed. (M.O.W.)

1497 SUPPRESSION OF CYCLOTRON INSTABILITY OF A RAREFIED PLASMA WITH THE AID OF A FEEDBACK SYSTEM. Arsenin, V. V.; Zhil'tsov, V. A.; Likhtenshtein, V. Kh.; Chulnov, V. A. JETP Lett. (USSR) (Engl. Transl.), 8: 41-4(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 69-72(July 20, 1968).

It is known that a magnetized plasma with an anisotropic ion velocity distribution ($\tau = T_\perp/T_\parallel > 1$, $T_\perp$ and $T_\parallel$ are the transverse and longitudinal temperatures) should be unstable at the ion cyclotron frequency and its harmonics $\omega \approx n\omega_{Hi}$, $n = 1, 2, \ldots$ If τ is not too large, the buildup takes place at the intersection ("resonance") of the Langmuir and cyclotron branches of the oscillations: $\omega_{Oe} \approx n\omega_{Hi}$, where ω_{Oe} is the electron Langmuir frequency. It is obvious that the resonance, and with it the instability, can be disrupted by turning on some mechanism of sufficiently strong damping of the Langmuir oscillations. In this investigation the damping was introduced by means of a special electronic system with feedback to control the perturbed fields outside the plasma. The requirements that must be satisfied by this system are described by considering a simple model, viz., a cylinder ($r < a$, $|z| < b$) of a rarefied plasma ($\mu^{1/2}\omega_{Oe} \ll \omega_{Hi}$, where μ is the ratio of the electron and ion masses), with z axis directed along an external homogeneous field $\vec{H}$. (M.O.W.)

1498 LEAST STABLE MODE IN CYLINDRICAL SYSTEMS. Krueger, J. G.; Callebaut, D. K. (Univ. of Ghent). Z. Naturforsch., 23a: 1357-61(Sept. 1968).

The stability of a magnetodynamic equilibrium system for perturbations ξ depending on a parameter α is investigated. Growth rates are compared (rather than only the second-order energy variations) without calculating them explicitly. The explicit dependence on α as well as the implicit dependence on α through ξ is taken into account. (auth)

1499 LOW-FREQUENCY INTERCHANGE INSTABILITY IN AN AVERAGE WELL. Ohkawa, T. (Gulf General Atomic Inc., San Diego, Calif.). Kakuyugo-Kenkyu, 21: 65-72(July 1968).

The dispersion relation is calculated for the interchange instabilities due to the resonance between the drift wave and the grad B drift motion of ions. Either a low plasma density or nonisotropic temperature may lead to instability. (NSA of Japan)

1500 ION–ION VELOCITY SPACE INSTABILITY. Grewal, Mahesh S. (Univ. of California, Livermore). Phys. Fluids, 11: 2491-3(Nov. 1968).

An electrostatic instability caused by the difference between $\theta_{\perp-i}$ and $\theta_{\parallel-i}$, the ion temperatures perpendicular and parallel to magnetic field, is discussed. Results show that the instability disappears as the ratio $\theta_{\perp-i}/\theta_{\parallel-i}$ approaches roughly a value of 16 and also when for a given value of $\theta_{\perp-i}/\theta_{\parallel-i}$ the ratio $\theta_{\perp-i}/\theta_{\parallel-e}$ becomes large, $\theta_{\parallel-e}$ being the electron temperature parallel to the magnetic field. From the results it is also concluded that this instability disappears, irrespective of the values of $\theta_{\perp-i}/\theta_{\parallel-i}$, and $\theta_{\perp-i}/\theta_{\parallel-e}$, whenever the plasma density is low enough so that the square of ion gyrofrequency is greater than about 2.8 times the square of ion plasma frequency. (auth)

Shielding

Refer also to abstracts 1613 and 1766.

1501 (AD–671888) RADIATION DISTRIBUTION WITHIN A MULTISTORY STRUCTURE. Final Report, September 1964–December 1966. McDonnell, C.; Velletri, J. (Conesco, Watertown, Mass.). Feb. 1967. Contract DA-18-20-eng-3407. 99p. (TR–24; USNRDL-TRC–68-7). CFSTI.

Experiments designed to measure the attenuated radiation dose within a structure from both an infinite field of contamination and limited strips of contamination are described. The experimental results are compared with results calculated on the basis of existing theories. In the infinite field studies, the experiments were conducted on a structure having 49, 98, and 147 psf walls, but no floors. These experiments were designed to determine the dose distribution with different wall mass thickness. In the following series the structure was modified by adding floors of 48.6 psf and 97.2 psf with 49 and 98 psf walls. In this series, the effect of floors on the dose distribution was studied. Both structure center-line and off-center measurements were taken. Relatively good agreement, generally within 25%, was obtained between measured and computed reduction factors. In the limited strip studies, the same floor and wall combinations were used. The agreement between calculational and experimental dose rates for limited strips of contamination is good for a simple box-type structure; however, on upper stories of multistory structures large differences were noted, especially for close-in contamination. This difference is attributed partly to the scattered radiation emerging from the walls, which is assumed in the calculations to be symmetrical about the detector with respect to the horizon and unchanged with field widths. Experimental results indicated that the scattered radiation emerging from the walls is not symmetrical, but is more peaked in the upward direction. (auth) (USGRDR)

1502 (AD–671902) GROUND ROUGHNESS EFFECTS ON FALLOUT SHIELDING. Final Report. French, R. L.; Price, J. H.; Tompkins, K. W. (Radiation Research Associates, Inc., Fort Worth, Tex.). Jan. 15, 1968. Contract N00228-67-C-2019. 66p. (RRA-T–81; USNRDL-TRC–68-5). CFSTI.

The protection factor of a simple cylindrical structure exposed to an infinite plane ^{60}Co source (approximately equals 1.25 MeV) on the ground surface was calculated by Monte Carlo. The "buried-source" model was used to represent ground roughness. Source depths of 0, 0.5, and 1.0 in. were used to simulate smooth, rough, and very rough ground, respectively. The cylindrical structure was of concrete and had a 10-ft radius and an infinite height. Wall thicknesses of 20, 40, and 80 psf and detector heights of 3, 13, and 23 ft were considered. It was found that ground roughness enhances the protection factor of a structure (1) by reducing the incident radiation intensity and (2) by altering the energy and angle distribution of the incident radiation. The first effect was generally about twice as strong as the latter. Both effects are largest for the 3-ft detector height where, for all wall thicknesses, the protection factors were increased by a factor of approximately 4.5 by very rough ground. Calculations performed with the engineering method including ground roughness effects accounted for only about 75% of the protection factor enhancement. (auth) (USGRDR)

1503 (AD–672021) GREAT: A MONTE CARLO PROCEDURE FOR CALCULATING GAMMA-RADIATION ENVIRONMENTS ABOVE TERRAIN. Price, J. H. (Radiation Research Associates, Inc., Fort Worth, Tex.). Dec. 1, 1967. Contract N00228-67-C-2019. 58p. CFSTI.

The GREAT Monte Carlo procedure was written for the IBM 1130 computer to calculate the energy and angle distribution of the scattered gamma-ray flux at a point detector in an air-ground geometry resulting from a plane-isotropic monoenergetic gamma-ray source parallel to the air-ground interface. The source, which is finite and annular in shape, may be positioned below the smooth ground surface to simulate the effects of a source located on rough ground. The point detector is located on the vertical axis of the annular source. Initial photon parameters, path lengths, interactions and scattering angles are obtained by random sampling of appropriate probability distributions. Each photon is traced as it scatters within the defined geometry and estimates are made of the flux contribution at the detector from each collision. Portions of the procedure were taken from COHORT, a general purpose Monte Carlo procedure. However, much of the versatility of COHORT was sacrificed for speed and compactness, allowing GREAT to be compatible with the storage available in the IBM 1130 computer and to efficiently perform gamma-ray scattering calculations in an air–ground geometry. (auth) (USGRDR)

1504 (N–68–26973) STUDY OF PLASMA RADIATION SHIELDING. Final Report. (Avco-Everett Research Lab., Everett, Mass.). May 1968. Contract NAS-8-20310. 99p. (NASA–CR–61640). CFSTI.

The plasma radiation shield is an active device using free electrons, electric fields, and magnetic fields for the purpose of shielding astronauts from energetic solar-flare-produced protons. The concept of plasma radiation shielding is reviewed in the light of current studies. The available evidence indicates that the concept

is physically sound, but important practical questions remain in at least two areas: these have to do with establishment and control of the extremely high voltages required, and with integration of the concept into a realistic space vehicle design. (auth) (STAR)

1505 (RRA-M-85) CALCULATIONS OF FISSION-PRODUCT GAMMA-RAY DOSES IN SINGLE-COMPARTMENT ABOVE-GROUND CONCRETE STRUCTURES. Mooney, L. G.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). June 9, 1968. Subcontract 2267. 46p. (CONF-680601-34). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

For Oak Ridge National Lab., Tenn.

Parametric data describing structure protection coefficients for fission-product gamma-rays have been generated for use in analysis of the shielding effectiveness of above-ground concrete structures against the initial nuclear radiations produced by the detonation of a nuclear weapon. Calculations were performed first to determine the energy and angle distributions of the fission-product gamma-ray fluence at overpressure range to 100 psi from a nuclear weapon detonated at an altitude of 100 yards. These calculations showed that the energy and angle distributions of the fission product gamma-ray fluence at the 100 psi overpressure range did not vary significantly with yield. Neither did these distributions vary significantly with overpressure range for overpressures less than 100 psi. The calculated energy and angle distributions of the fission-product gamma-ray fluence incident on the roof and walls of rectangular structures for an overpressure range of 100 psi were used as source input data to an S_n code for machine calculations of the penetration of fission-product gamma rays through concrete slabs of various thicknesses. The penetration calculations used an S_{16} angle quadrature and a P_{12} expansion of the Klein–Nishina differential scattering cross section. The angular distributions of the emergent gamma-ray absorbed dose current for each slab orientation as a function of slab thickness were input to a machine procedure that was used to calculate fission-product gamma-ray absorbed doses at receivers placed 3 ft above the structure floor and at various positions within the structure for structures with square floor areas. Structure protection coefficients (absorbed dose at receiver per unit free-field absorbed dose) were computed for receivers positioned within concrete structures with an inside height of 10 ft and with length and widths of the structures varying between 10 and 50 ft for wall thickness of 6 to 60 inches. The calculated structure protection coefficients for receivers positioned 3 ft above the center of the floor area were fitted by an expression of the form $SPC(t,L,W) = A(L,W)e^{-t/a(L,W)} + B(L,W)e^{-t/b(L,W)}$ where t is the wall and roof thickness, L is the width of the front wall and W is the width of the side wall. Tabulated data are presented that show the dependence of the parameters A, B, a, and b on L and W. Graphical presentation is made to show the variation of the structure protection coefficient with distance from both the front and side walls for $\frac{1}{5} \leq L/W \leq 5$. (auth)

1506 (RRA-M-71) SIMPLIFIED METHOD FOR CALCULATING NITROGEN-CAPTURE AND FISSION-PRODUCT GAMMA-RAY DOSES INSIDE UNDERGROUND CONCRETE STRUCTURES. Marshall, J. D.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). June 11, 1967. Subcontract 2329. 31p. (CONF-670602-32). Dep. CFSTI.

From 13th Annual Meeting of the American Nuclear Society, San Diego, Calif.

For Oak Ridge National Lab., Tenn.

A simplified method has been developed to calculate the gamma dose at a detector position on the centerline of underground cylindrical structures that results from the fission-product and nitrogen-capture gamma rays produced by a nuclear weapon detonation. Application of the method requires knowledge only of the structure geometry and the fission-product and capture gamma-ray doses incident on the concrete cover shield of the underground structure. To provide the dose transmission data used in the calculational method, a series of S_n problems were run for isotropic and anisotropic fission-product and nitrogen-capture gamma rays incident on concrete slabs for thicknesses up to 60 inches. The gamma-ray dose at a detector on the centerline of the structure is calculated from the product of the outside dose, the transmission factor, and the fraction of the transmitted dose which reaches the detector. Functions defining the fraction of the transmitted dose reaching a detector positioned on the centerline of an underground cylindrical structure were derived for both the isotropic and anisotropic fission-product and nitrogen-capture gamma-ray source terms. (auth)

1507 FAST NEUTRON STREAMING THROUGH CONCRETE DUCTS. Song, Yo Taik. Urbana, Ill., Univ. of Illinois, 1968. 351p.

Thesis.

Work was conducted to evaluate the dose variations along the center line in two-legged concrete ducts. The two-legged concrete duct has been used as a model for shelter entranceways for the personnel shelters for the initial radiation from nuclear weapons. Fast neutron streaming through two-legged air ducts in concrete was investigated theoretically and experimentally. In the theoretical study, the albedo concept was employed, and numerical values of the neutron dose in ducts of various sizes were calculated by means of an IBM 1620 computer. Sources employed were neutrons from the T(d,n)^{4}He, etc., reaction (14 MeV), D(d,n)^{3}He reaction (2.5 MeV), and neutrons from a plutonium–beryllium source. Three sizes of concrete ducts were used as models: (1) a 3 × 3-foot duct with a first-leg length of 15 feet; (2) a 2 × 3-foot duct with a 12-foot first leg; and (3) a 2 × 2-foot duct with 12- and 7-foot first legs. In the experiments, counting rates of a spherical dosimeter were measured in both the first and second legs of these ducts for the various neutron sources. Comparisons show generally good agreement between theoretical and experimental results for a range of attenuation covering about seven decades. For monoenergetic neutron sources, the agreement was always within 40%; for the plutonium–beryllium source, the discrepancy was as large as 55%. (Disser. Abstr.)

1508 PENETRATION OF HIGH-ENERGY, HEAVY IONS, WITH THE INCLUSION OF COULOMB, NUCLEAR, AND OTHER STOCHASTIC EFFECTS. Litton, Gerald Murray. Berkeley, Calif., Univ. of California, 1967. 167p.

Thesis.

A general method was developed for calculating Bragg curves, flux curves, and energy spectra resulting from beams of high-energy, heavy ions incident on an arbitrary target. The method takes into account the processes of energy loss from both electronic and nuclear elastic collisions, nuclear attenuation, small-angle multiple scattering, and straggling, as well as effects due to initial energy and angular spreads of the beam. Calculations were made for ions of various atomic numbers incident on different targets. It is found that for a given range in a particular target, the peak-to-plateau dose ratio goes through a maximum as the atomic number of the incident ions increases. Similarly, the Bragg-peak full width at half-maximum goes through a minimum. Another significant result is that for a given particle range, the average energy per nucleon at the Bragg peak is nearly independent of the bombarding ion, and also of the target material. The calculated results agree very well with experimental data for most cases in which secondary-particle production is of minor importance. In addition, even when secondaries are a large contributing factor, the method yields valuable information regarding the variation in energy deposition with the atomic number of the penetrating particles. The calculated results are found to be quite sensitive to the degree of angular and energy spreading of the initial beam. (Disser. Abstr.)

1509 BACKSCATTERING OF GAMMA RAYS FROM TIN SLABS. Nishi, Masatsugu; Nakamura, Takashi (Kyoto Univ.). Mem. Fac. Eng., Kyoto Univ., 29: 474-82(Oct. 1967).

The backscattering of gamma rays from tin slabs was investigated as a function of slab thickness. The point isotropic ^{60}Co and ^{137}Cs sources were placed on the front face of the scatterer. The obtained data were converted to the response-corrected spectra with the aid of an inverse response matrix, and the angular and energy distributions of backscattered photons were obtained and compared with the other experimental and calculated results. (NSA of Japan)

1510 METHOD FOR MEASURING THE SHIELDING EFFECTIVENESS OF A HETEROGENEOUS STRUCTURE FOR SHIELDING AGAINST FUNDAMENTAL CHARGED PARTICLES. Mittelman, Phillip Sidney; Ross, Richard C. (to United Nuclear Corp.). U. S. Patent 3,404,274. Oct. 1, 1968. Filed Sept. 12, 1963.

A method for measuring the shielding effectiveness of a heterogeneous structure for shielding against fundamental charged particles is described. More particularly, it relates to a method utilizing a gamma source and detector for determining the effectiveness of a space vehicle for shielding against fundamental charged particles, especially protons. (B.G.D.)

Solid-State Physics

Refer also to abstracts 304, 686, 1213, 1219, 1580, 1878, 1880, and 1932.

1511 (AD-661283) TUNGSTEN COMPOUNDS AS LIQUID ABSORBERS FOR MOESSBAUER EXPERIMENTS. Report No. Scientific-1. Weinzierl, P. (Technische Hochschule, Vienna (Austria). Institut fuer Experimentalphysik (II). July 30, 1967. Contract AF61(052)-845. 26p. (AFOSR-67-2581).

The recoilless fraction f_A of Na_2WO_4 and of the tungsten (VI) halides WF_6 WCl_6 and WO_2Cl_2 is measured at 77°K in a Mössbauer transmission experiment using the 46.5-keV transition in ^{183}W. The Debye temperatures of these compounds were derived and the feasibility of Mössbauer transmission experiments with tungsten (VI) halides near the melting point as absorbers is discussed with respect to the study of diffusion. (auth) (USGRDR)

1512 (INP–617) ENERGY SPECTRA OF SPIN LATTICES IN MAGNETIC CRYSTALS WITH IMPURITIES. Krasnicki, Szozesny (Institute of Nuclear Physics, Krakow (Poland)). May 1968. 58p. (In Polish). Dep.

A general review of existing theories of the energy spectrum in a magnetic crystal containing one or more impurity atoms is given. Only the excited states of the spin lattice are dealt with. The possibilities of experimental checking of the theory are discussed and special attention is paid to the method of inelastic magnetic scattering of neutrons. (auth)

1513 (N–68–27439) RECOMBINATION LIFETIMES IN GAMMA-IRRADIATED P-TYPE FLOAT ZONE SILICON. Hewes, Ralph A.; Compton, W. Dale (Illinois Univ., Urbana. Dept. of Physics). [1966]. 29p. (NASA-CR–82348). CFSTI.

Much research has been done in recent years on the defects introduced into silicon by irradiation. Hall effect, photoconductivity and infrared absorption, and spin resonance measurements, along with lifetime studies, have now been performed on electron and gamma-irradiated materials (n- and p-type) crucible-grown and floating-zone grown. Knowledge of the defects controlling recombination is of particular interest, since many important processes in semiconductor devices are controlled by the minority carrier lifetime. When the recombination levels coincide with the major defect levels, as appears to be the case in n-type silicon, lifetime measurements yield the values of the capture cross sections. When the recombination is controlled by defects which are not easily, if at all, detected by other techniques, lifetime measurements may be the only means of obtaining information about these defects. This appears to be the case for at least some of the recombination defects in p-type floating-zone grown silicon. (auth) (STAR)

1514 (N–68–27639) PROTON DAMAGE TO SILICON AS A FUNCTION OF PROTON ENERGY. Breckenridge, Roger A.; Gross, Chris (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1967]. 15p. (NASA-TM-X–60124). CFSTI.

It is important for NASA to be able to predict the amount of damage produced in silicon electronic devices by the high-energy protons which are present in space. To accomplish this, the dependence of the proton damage on the energies of the incident protons must be known. It was the purpose of the experiments reported to provide this information. The energy dependence of the majority carrier removal rates in n- and p-type silicon single crystals for the energy range from 10.7 to 53.25 MeV has been established by means of the determination of the Hall coefficient of the silicon. The results that have been obtained are directly applicable to majority carrier devices such as the junction field-effect transistor. (auth) (STAR)

1515 (NP–17579, pp III.3–11) SOLID STATE PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Progress of research in the following fields is summarized briefly: physical properties of metals, ionic crystals, and metal oxides; electron microscopy; and elastic and inelastic neutron scattering. Results on the following are shown in figures: temperature dependence of the Hall mobility in $V_2O_{3-\gamma}$ single crystals, phase diagram of the system $UO_2-U_4O_9$, uranium self-diffusion in UO_2 as function of temperature, and isothermal and isochronal annealing of cold-worked Mo. Photographs from electron microscopy studies of the following are shown: superstructures of niobium and tantalum pentoxides, interfacial dislocation in WO_3, order twins and antiphase boundaries in NiMn, defect structure due to ordering in Ni_4Mo, wavy fringes at domain boundaries in barium titanate, and contrast effects at interface between polytypes in cobalt–chromium alloy. (A.G.W.)

1516 (NYO–3474–5) COLOR CENTERS AND THE THERMOLUMINESCENCE PROCESS IN LiF:Mg. Mayhugh, M. R.; Christy, R. W.; Johnson, N. M. (Dartmouth Coll., Hanover, N. H.). Sept. 30, 1968. Contract AT(30-1)-3474. 12p. (CONF-680920–4). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

A systematic study of radiation-induced color centers in LiF: Mg has been made at low dose to help understand the thermoluminescence mechanism in this material. Important Mg-related optical absorption was observed from 310 to 380 nm. In particular the main thermoluminescence dosimetry peak is associated with the centers that produce a 310-nm absorption band. Furthermore, the thermoluminescence mechanism in this glow peak and two related ones is shown to involve electrons thermally released from 310-nm centers. This identification is made from the results of 310- and 250-nm optical bleaching experiments on thermoluminescence samples. Complexes involving Mg^{++} ions, cation vacancies, and anion vacancies are suggested as electron traps. (auth)

1517 (RLO–1388–540) SPIN WAVE INTERACTIONS AND THE LOW TEMPERATURE BEHAVIOR OF THE HEISENBERG FERROMAGNET. Shaw, William Morse (Washington Univ., Seattle). Aug. 1968. Contract AT(45-1)-1388. 261p. Dep. CFSTI.

Thesis.

An investigation was made of spin wave interactions and their effects upon low-temperature properties of the spin-½ Heisenberg ferromagnet. In a new technique, boson creation and annihilation operators are combined with projection operators to produce the spin operators associated with each site. These spin operators are then used to construct a Hamiltonian which treats as a vacancy any site with two or more spin deviations. This Hamiltonian is further modified by the addition of a repulsive core of the form $\frac{1}{2}R = \frac{1}{2}\Lambda\Sigma_i (a_i^\dagger)^2 (a_i)^2$ $(\Lambda > 0)$ which in the limit $\Lambda \to +\infty$ prevents two or more spin deviations from occupying the same site. In this investigation, the thermodynamic Green's function formalism of Martin and Schwinger is used along with a T-matrix approximation for the Green's functions. This formulation is used to investigate two spin-wave interactions and their contributions to the low-temperature free energy and magnetization. Examination of two spin-wave interactions at T = 0°K yields exact expressions for the T matrix, scattering amplitude, and differential cross section. Dyson's long-wavelength scattering cross section is reproduced. At large total momenta, bound states appear and the thresholds for their existence are determined. Examination of the effects of spin-wave interactions on the low-temperature free energy and magnetization yields results in agreement with the exact results of Dyson. The Green's function formulation with the T-matrix approximation is also used to develop the self energy and spectral function for a single spin wave. Detailed expressions for the low-temperature self-energy are obtained, and properties of the spectral function are examined. Finally a proposal is made to extend and improve the theory in order to calculate the effects of spin-wave interactions on inelastic neutron scattering. (auth)

1518 (UCRL–71090) TLD SUPRALINEARITY AND OPTICAL ABSORPTION IN LiF CRYSTALS. Grant, R. M.; Jones, D. E. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 4, 1968. Contract W-7405-eng-48. 8p. (CONF-680920–2). Dep. CFSTI.

From 2nd International Conference on Luminescence Dosimetry, Gatlinburg, Tenn.

The thermoluminescence (TL) of irradiated LiF: Mg crystals has been shown to be linear with dose over a certain range, after which it rises more sharply in a region of supralinearity before saturating at high doses. Several investigators have shown that the relative sensitivity (TL/R, where R is the exposure dose) of this phosphor in the supralinear region depends on the quality of the radiation as well as on the total dose. This paper reports an experiment designed to measure both the radiation-quality-dependent TL supralinearity and the simultaneous changes in two of the optical absorption bands (250 nm and 310 nm) of TLD-100. The samples were 1-cm cubes cleaved from a small portion of a large ingot. For TL measurements some of the cubes were powdered. Optical measurements were made after each increment of exposure while TL measurements were made at the end of all irradiations. Small samples of the powder were removed for subsequent TL reading after each exposure increment. Exposure rates were chosen so the absorbed dose rates were similar for the two irradiation sources (40-keV effective x rays and ^{60}Co γ rays). This was done to compare quantitatively the growth rates of the absorption bands and the TL. The data show that the F bands (250 nm) grow at nearly the same rate for both sources whereas the 310-nm bands grow faster with ^{60}Co γ irradiation than with 40-keV effective x irradiation. The TL data show changes in relative sensitivity that are strongly dependent upon dose normalization. Because of this dependence the absorbed dose calculation is presently being studied to see if a quantitative comparison of the TL data can be made with that of the optical absorption. (auth)

1519 CRYSTAL GROWTH AND MAGNETIC SUSCEPTIBILITY OF SOME RARE-EARTH COMPOUNDS. PART 1. CRYSTAL GROWTH. Garton, G.; Wanklyn, B. M. (Oxford Univ.). J. Mater. Sci., 3: 395–401(July 1968).

Single crystals of the following types of rare-earth compounds were obtained by the fluxed-melt method of crystal growth: ROF, $R_2Ti_2O_7$, R_2TiO_5, $RNbO_4$, R_3NbO_7 (R = rare-earth metal). The experimental conditions are described and x-ray diffraction data are presented for compounds not previously reported. (auth) (UK)

1520 CRYSTAL GROWTH AND MAGNETIC SUSCEPTIBILITY OF SOME RARE-EARTH COMPOUNDS. PART 2. MAGNETIC SUSCEPTIBILITY MEASUREMENTS ON A NUMBER OF RARE-EARTH COMPOUNDS. Cashion, J. D.; Cooke, A. H.; Leask, M. J. M.; Thorp, T. L.; Wells, M. R. (Oxford Univ.). J. Mater. Sci., 3: 402-7(July 1968).

Magnetic susceptibility measurements were made on five series of rare-earth compounds using an ac mutual inductance technique. The compounds satisfy the general formulae $RNbO_4$, R_3NbO_7, R_2TiO_5, $R_2Ti_2O_7$, or $RAlO_3$, where R is a rare-earth ion. The measurements were mainly carried out in the helium range 1 to 4.2°K, and the results analyzed in terms of the general Van Vleck formula $\chi = C/(T + \theta) + \alpha$. Many of the compounds were observed to undergo antiferromagnetic transitions, and in some cases showed evidence of extremely anisotropic behavior above the Néel temperature. (auth) (UK)

1521 CHARACTERISTIC ELECTRON ENERGY LOSSES IN SOLIDS. Laznicka, Mojmir. Pokroky Mat. Fys. Astron., 13: 237-48(1968). (In Czech).

Studies were made of the electron energy losses in interactions with solids. Measurements were made of the energy spectra of reflected and secondary electrons in NaCl monocrystals considering that the primary electron energy was E = 21.5 eV. (R.V.J.)

1522 LIMITS OF MEASUREMENT IN MAGNETIC RESONANCE. Hill, H. D. W.; Richards, R. E. (Oxford Univ.). J. Phys., E (London), 1: 977-83(Oct. 1968).

The various factors that affect the signal-to-noise ratio with which a magnetic resonance can be detected are discussed. The analysis is in terms of nuclear resonance, but the differences for electron resonance are pointed out. The methods of optimizing the parameters involved are described and typical values are given. In favourable cases significant changes in the resonance intensity may be achieved by double resonance methods; some of these methods are described briefly. (auth) (UK)

1523 SIMPLE FURNACE FOR HIGH TEMPERATURE NUCLEAR MAGNETIC RESONANCE EXPERIMENTS. Warren, W. W. Jr.; Clark, W. G. (Univ. of California, Los Angeles). J. Phys., E (London), 1: 1019-21(Oct. 1968).

A furnace for nuclear magnetic resonance experiments between room temperature and 1300°C is described. It is easy to construct, and has an option for control of the atmosphere surrounding the sample or application of a uniaxial stress to the sample. The power requirement for operation at 1000°C is 130 W. Sufficient external cooling is provided by the laboratory environment. (auth) (UK)

1524 RADIATION EFFECTS IN LITHIUM FLUORIDE CRYSTALS. Shvarts, K. K.; Vitol, A. Ya.; Kalnin'sh, D. O.; Lusis, D. Yu.; Podin'sh, A. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 31: 2028-34(Dec. 1967). (In Russian).

The formation of color centers in LiF was studied as a function of the temperature (100 to 400°K), the type of irradiation (x, γ, or reactor), and the absorbed dose. Optical spectroscopy in 2- to 11-11-eV range, EPR, density measurements, and electron microscopy methods were used in experiments with crystals produced in vacuum and in air, and with crystals activated by uranium. Irradiation of crystals in a reactor at 10^{19} n/cm^2 followed by water cooling indicated F centers as main paramagnetic centers; irradiation without water cooling showed formation of aggregate and colloidal centers starting with 10^{18} n/cm^2 dose; heating the crystals from 500 to 550°K during irradiation enhances formation of colloidol centers. Comparison of the EPR and electron microscope data on colloidal particles in irradiated LiF crystals with the Dyson theory showed good agreement. Other data also indicated certain peculiarities in color center formation as a result of the dose and type of irradiation. (R.V.J.)

1525 ON THE INTERFERENCE BETWEEN RAYLEIGH AND MOESSBAUER SCATTERING AND THE SPIN DEPENDENCE OF RAYLEIGH SCATTERING. Renz, W. (Univ., Karlsruhe). Z. Phys., 217: 63-82(1968). (In German).

The interference of Moessbauer scattering and Rayleigh scattering was examined, and it was found that this interference can be easily observed under certain conditions. The experiment was initially carried out with a single-line transition of the 14-keV energy level of ^{57}Fe. From the experimental data the contribution of Rayleigh scattering could be determined relative to Moessbauer scattering and it could be shown that by measuring the interference of Moessbauer scattering and Rayleigh scattering one will have a sensitive detector for Rayleigh scattering. This was used to test the spin dependence of Rayleigh scattering. For this purpose, a similar experiment was carried out with circularly polarized γ quanta and polarized electrons, making use of the splitting of the ^{57}Fe hyperfine structure. By comparison of the measured values for left-handed and right-handed circularly polarized components a strong spin dependence of the Rayleigh scattering was found. (auth)

1526 TEMPERATURE DEPENDENCE OF THE MAGNETIC ORDERING IN Gd–$GdFe_2$ PHASE MIXTURES. Sivonen, S. J.; Suoninen, E. J. (Univ. of Oulu, Finland). Phys. Status Solidi, 29: K171-3(Oct. 1, 1968).

The magnetic behavior of Gd–Fe alloys containing 0 to 18.9 at. % Fe was investigated at temperatures of 285 to 800°K. For samples induction-melted in vacuum and slowly cooled to room temperature without additional heat treatment, the magnetization decreased in two steps with increasing temperature, corresponding to two Curie temperatures practically independent of sample composition. Studies of samples cooled at different rates and given additional heat treatments indicated that the previously reported Curie temperature at 790°K corresponds to a supersaturated measurable state formed on cooling unless the sample is cooled very slowly. Annealing causes a continuous transition to the stable state and a corresponding continuous lowering of the Curie temperature toward the value of 490°K found for slowly cooled samples. (A.G.W.)

1527 EFFECTS OF FISSION FRAGMENTS ON ELECTRIC PROPERTIES OF THE UO_2–SiO_2 SYSTEM. Cojocaru, L. N. (Inst. for Atomic Physics, Bucharest). Phys. Status Solidi, 29: K119-22(Oct. 1, 1968).

The effects of fission fragments on the electric properties of UO_2–SiO_2 samples containing 40 to 70% UO_2 were measured. In the temperature range 350 to 1000°K the activation energy was only very slightly influenced by irradiation. The electric conductivity decreased after irradiation by a factor depending on sample composition. The temperature dependence of the thermoelectromotive force of the irradiated samples had a shape similar to that of unirradiated samples, but the values were changed. Interpretation of the results in terms of carrier concentrations and lattice defects is considered briefly. (A.G.W.)

1528 GRAIN GROWTH IN THIN FILMS OF ThO_2, NpO_2, AND PuO_2. Bronisz, S. E.; Douglass, D. L. (Los Alamos Scientific Lab., N. Mex.). Phys. Status Solidi, 29: K95-7(Oct. 1, 1968).

Transmission electron microscopy was used to observe crystallization and grain growth in ThO_2, NpO_2, and PuO_2 films during annealing in the microscope. Temperatures estimated to be ≈ 1500°C were necessary to cause a significant increase in the grain size of any of the oxides. The maximum grain size obtained in a single-layer foil was 1 μm, but grains as large as 4 μm were found in areas where layers of foil overlapped. The as-deposited films were randomly oriented, but the grains in the fully annealed structure had a definite preferred orientation. Most of the annealed grains contained one, two, or three sets of striae. (A.G.W.)

1529 MAGNETIC PROPERTIES OF SOME Co-RICH ERBIUM–COBALT INTERMETALLIC COMPOUNDS. Buschow, K. H. J.; Fast, J. F.; van der Goot, A. S. (Philips Research Labs., Eindhoven, Netherlands). Phys. Status Solidi, 29: 825-9(Oct. 1, 1968).

The magnetization for the ferrimagnetic compounds Er_2Co_{17}, $ErCo_6$, and Er_2Co_7 has been studied in the temperature range 4.2 to 1250°K and at field strengths up to 30 kOe. The Curie temperatures and the saturation magnetizations at 4.2°K have been determined. For all compounds a maximum has been observed in the magnetization versus temperature curves. Er_2Co_7 shows a compensation point at 140°K. For this compound changes in the crystalline anisotropy were observed near the compensation point. The values of the coercive force obtained by mortar-grinding samples of Er_2Co_{17}, $ErCo_6$, Er_2Co_7, and $ErCo_3$ are compared with the variation of the lattice parameters for these compounds. (auth)

1530 LOW-TEMPERATURE NEUTRON RADIATION DAMAGE AND RECOVERY IN BERYLLIUM. Delaplace, J.; Nicoud, J. C.; Schumacher, D.; Vogl, G. (CEN, Grenoble, France. Technische Hochschule, Munich). Phys. Status Solidi, 29: 819-24(Oct. 1, 1968).

In beryllium neutron-irradiated at 4.2°K, the defect production and subsequent recovery up to 350°K have been studied by means of electric resistivity measurements. The data are discussed in view of present knowledge of point-defect phenomena in other metals, in particular aluminum, which exhibits after neutron irradiation a recovery behavior similar to that of Be. (auth)

1531 SCATTERING EFFECTS WITH CHANNELED IONS. von Jan, R. (Institut Max von Laue–Paul Langevin, Grenoble, France). Phys. Status Solidi, 29: 755-9(Oct. 1, 1968).

The angular distribution $F(\alpha)$ is calculated for fast ions that have traversed a lattice channel with an axis in the direction $\alpha = 0$. For both axial and planar transmission channeling, intensity maxima are expected at $|\alpha_{max}| = \alpha_0\sqrt{(1-\eta^t)/(1-\eta^l)}$, where α_0 is the angle of incidence, and η^t and η^l denote the relative energy loss of transverse and longitudinal motion. The scattering effects provide a direct method to measure separately longitudinal and transverse stopping powers for channeled ions. (auth)

1532 THE STUDY OF SLIP BANDS ON THE SURFACE OF Mo SINGLE CRYSTALS. Vesely, D. (Inst. of Physics, Prague). Phys. Status Solidi, 29: 585-96(Oct. 1, 1968).

Single crystals of molybdenum, with the orientation of the tensile axis in the middle of the stereographic triangle, were deformed at 293 and at 400°K, to different degrees of plastic deformation at a strain rate $\dot{\epsilon} = 6 \times 10^{-5}$ sec^{-1}. The slip bands on the cylindrical surface of the crystals were studied by optical microscopy. At room temperature, at the beginning of deformation, a large number of slip systems with all four Burgers vectors are found to be operative. It is found that the slip planes do not correspond to those with maximum resolved shear stress, but rather to planes perpendicular to the surface. The slip bands belonging to the planes with maximum resolved shear stress are more pronounced when the temperature and flow stress are increased; at 400°K, in the region I, the primary slip system is dominant. These observations are explained assuming that screw dislocations have a low mobility which can change under the influence of temperature and stress. (auth)

1533 THE STUDY OF DEFORMATION OF THIN FOILS OF Mo UNDER THE ELECTRON MICROSCOPE. Vesely, D. (Inst. of Physics, Prague). Phys. Status Solidi, 29: 675-83(Oct. 1, 1968).

The slip geometry in molybdenum has been studied at room temperature by tensile deformation of thin foils under an electron microscope. The orientation of the tensile axis was in the middle of the stereographic triangle; consequently the system with maximum resolved shear stress was $(\bar{1}01)$ [111]. Observations have shown that the choice of slip systems depends not only on the orientation factor of the slip systems but very strongly on the orientation of the foil plane. In the present work this phenomenon is explained by assuming that the difference in the mobilities of screw and edge dislocations is sufficiently large to influence the choice of slip systems. The most active systems are those in which the dislocation loops can easily lose their screw component to the surface leaving the edge component to propagate through the foil. (auth)

1534 DIFFUSION MECHANISMS AND POINT DEFECTS IN SILICON AND GERMANIUM. Seeger, A.; Chik, K. P. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart.). Phys. Status Solidi, 29: 455-542(Oct. 1, 1968).

Emphasis in this review is on general principles and techniques rather than on collection of experimental data. Experimental methods are summarized in two broad categories: (1) diffusion studies and measurements that detect the presence of point defects in thermal equilibrium and (2) experiments in which the point defects are not in thermal equilibrium (quenching from high temperatures, plastic deformation, and irradiation by fast particles or γ rays). Theoretical interpretation of the various types of experiments is discussed. Promising directions for future research are indicated. (280 references). (A.G.W.)

1535 DESIGN CURVES FOR PREDICTING FAST-NEUTRON-INDUCED RESISTIVITY CHANGES IN SILICON. Buehler, Martin G. (Texas Instruments Inc., Dallas). Proc. IEEE (Inst. Elec. Electron. Eng.), 56: 1741-3(Oct. 1968).

From experimental observations, resistivity–fluence design curves have been determined for reactor neutrons in silicon at room temperature. (auth)

1536 ELECTRICAL TRANSPORT PROCESSES IN BERYLLIUM OXIDE. Cline, Carl F.; Newkirk, Herbert W. (Univ. of California, Livermore). J. Chem. Phys., 49: 3496-3504(Oct. 15, 1968). (UCRL-70960).

The electrical resistivity was determined for polycrystalline and single-crystal BeO between 1200 and 1700°C. Analysis was made of the effects of oxygen partial pressure, aliovalent impurities, and microstructure. Conductivity and relevant diffusion coefficients were calculated with these data. The results show the BeO samples to be impurity-controlled ionic conductors, and establish the need for higher-purity material to study intrinsic properties. Electrical migration is independent of grain boundaries and crystallographic direction. Creation of cation defects by varying the oxygen activity in the specimens is not an important process in this material. At high temperatures, above a critical roll-over temperature determined by the impurity content, electrical transport processes occur by a vacancy mechanism with an activation energy of 65 ± 5 kcal/mole. At lower temperatures, the electrical transport process is more complex and no simple theory is applicable. It is suggested that precipitation of impurities may be a more important process than the association of vacancy–impurity complexes in this system. The activation energy for this process depends inversely on the amount of aliovalent impurities present in the sample, and has a value of 73 kcal/mole at the lowest concentration studied. (auth)

1537 NMR PROPERTIES OF ^{14}N IN ThN AND OF ^{31}P IN ThP. Kuznietz, Moshe (Argonne National Lab., Ill.). J. Chem. Phys., 49: 3731-2(Oct. 15, 1968).

Continuous-wave NMR measurements were made on fine-powder samples of stoichiometric ThN and nearly stoichiometric $ThP_{0.95}$ in various magnetic fields and at temperatures from 77 to 300°K. The shapes and widths of the lines obtained for both compounds were independent of temperature and applied magnetic field. The positive Knight shifts, $+(10.7 \pm 1.5) \times 10^{-4}$ for ^{14}N in ThN and $+(4.4 \pm 0.2) \times 10^{-4}$ for ^{31}P in ThP, are independent of temperature. (A.G.W.)

1538 LONG-RANGE ANTIFERROMAGNETIC SPIN CORRELATIONS IN SCANDIUM METAL. Wohlleben, D. (Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 21: 1343-6(Oct. 28, 1968).

Alloys of Sc with magnetic impurities show strong anomalies in the concentration dependence of the impurity interaction temperature. This is interpreted with exchange enhancement of the susceptibility of metallic Sc near a finite wave vector. (auth)

1539 PHONON SCATTERING BY RADIATION-PRODUCED COLLOIDS IN SILVER CHLORIDE. Bausch, W.; Guckenbiehl, F.; Waidelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 28A: 38-9(Oct. 21, 1968).

From measurements of the thermal conductivity of "pure" and γ-irradiated AgCl between 2 and 250°K it is inferred that large silver colloids are formed. (auth)

1540 MAGNETIC SUSCEPTIBILITY OF SCANDIUM. Cullen, J. R.; Callen, E. (Naval Ordnance Lab., White Oak, Md.). Phys. Lett., 28A: 20-1(Oct. 21, 1968).

The form that the enhanced susceptibility takes for the case of two overlapping bands is derived. The calculation is carried to second order in magnetic field and temperature. (auth)

1541 NMR IN PARAMAGNETIC $NdBr_3$ AND UI_3 AND IN ANTIFERROMAGNETIC UI_3. Parks, Stephen Ira. Tallahassee, Florida State Univ., 1967. 123p.

Thesis.

The NMR spectra of $NdBr_3$ and UI_3 above the Neel temperature, and of UI_3 below the Neel temperature have been measured and the dependence of frequency on temperature has been analyzed. In UI_3 the line spectra were analyzed by a least-squares computer technique. At the C site $e^2qQ/h = 365$ MHz, $\eta = 0.1537$. The internal magnetic field H had a zero-temperature asymptote of 14.1 kG at a direction $\theta = 89.07°$, $\phi = 87.9°$, with θ and ϕ measured from the V_{zz} and V_{xx} axes respectively. Two magnetically inequivalent F sites were observed: for both of them $e^2qQ/h = 183$ MHz and $\eta = 0.7058$; on site 1, H = 17.39 kG, $\theta = 57.65°$, $\phi = 84.38°$; on site 2, H = 17.41 kG, $\theta = 57.44°$, and $\phi = 86.9°$. The magnetization curve is abrupt: at 2.4°K (0.92 T_N) the sublattice magnetization is still greater than 92% of its zero-temperature asymptote, indicating a very large anisotropy. In $NdBr_3$ the values for the C site at room temperature are $e^2qQ/h = 89.076$ MHz, $\eta = 0.068$; for the F site $e^2qQ/h = 45.348$ and $\eta = 0.487$. The temperature dependence of the F site resonance frequency showed an unusual upward curvature which was interpreted as resulting from a low-lying excited state of the Nd^{3+} ion. (Disser. Abstr.)

1542 MAGNETO-OPTICAL STUDIES OF THE CaO F BAND. Ziniker, William Merle. Eugene, Oreg., Univ. of Oregon, 1967. 83p.

Thesis.

The fundamentally important defect consisting of an electron trapped at a negative-ion vacancy and known as the F center occurs in single crystals of the alkaline earth oxides which have been exposed to large fluxes of fast neutrons. The optical absorption band (F band) of the F center was located in CaO. The location of the F band in MgO was also confirmed, in agreement with the results of other types of experiments. The chief experimental technique used in this work was optical Faraday rotation. The apparatus used permitted measurement of sample rotations in the spectral range of 7000 to 2500Å and at temperatures of 4.2 to about 1.8°K. Magnetic fields up to 45,000 gauss were available. The experiments used to locate the F band combined Faraday rotation with microwave absorption. The paramagnetic portion of the Faraday rotation in the F band can be changed if the equilibrium populations of the ground state Zeeman levels are disturbed

by resonant absorption of microwave power. Since the Faraday rotation is not changed at other wavelengths, the microwave and optical absorptions are thus unambiguously correlated. Although this technique of "Faraday rotation–ESR double resonance" was successfully applied only to the case of the F center which has a relatively strong and narrow microwave absorption, the method holds promise as a means of studying other paramagnetic point defects and their optical absorptions. Also, the return of the Faraday rotation to its equilibrium value following microwave excitation provides a way to measure spin–lattice relaxation times. A value of about 25 seconds was obtained for the CaO F center. Negative-ion vacancies in the divalent alkaline earth oxides might be expected to trap two electrons (F′ center). No evidence for F′ centers in neutron-irradiated samples is known. However, experiments were performed on additively colored CaO which gave evidence of the presence of F′ centers. Light irradiation treatments at low temperatures were discovered that caused the F band to increase (decrease) in size while a band (assumed to be the F′ band) not seen in neutron-irradiated samples simultaneously decreased (increased). The strength of the F-center ESR absorption was correspondingly altered. These results are tentatively interpreted as evidence for F–F′ photoconversion. Experiments were carried out which involved the sharp line structure seen on the low-energy side of the CaO F band. The results support the interpretation of these lines as no-phonon and phonon-assisted transitions of the F center. The presence of these lines indicate a weaker electron-lattice interaction than in alkali halide F-centers where they are not seen. (Disser. Abstr.)

1543 NATURE OF TRAPPING AND LUMINESCENCE CENTERS DUE TO THALLIUM IN GLASS. Ghosh, A. K. (Argonne National Lab., Ill. Itek Corp., Lexington, Mass.). J. Phys. Chem. Solids, 29: 1387-93(Aug. 1968).

The radiation-induced absorption bands of thallium-doped aluminoborate glass and fused silica are attributed mainly to centers like Tl° (atom) and Tl^{2+} ions. The Tl^{+} ions in glass trap both electrons and holes. The afterglow and thermoluminescence emissions observed in aluminoborate glass are attributed to recombination luminescence. Holes recombining with Tl° centers and electrons recombining with Tl^{2+} centers result in emission characteristic of Tl^{+} ions. (auth) (UK)

1544 REACTION ORDER FOR INTERSTITIAL-VACANCY RECOMBINATION IN COLD-WORKED NIOBIUM. Stals, L.; Nihoul, J.; Gevers, R. (SCK, Mol, Belg.). Bull. Belg. Phys. Soc. (5), No. 1, 25-8(1966).

By means of electrical resistivity measurements a singly-activated recovery stage is observed in cold-worked niobium between 80 and 180°C. This stage has been ascribed to a recombination of interstitials with vacancies. Using Waite's theory for diffusion-controlled processes, it is demonstrated that the order of reaction γ of the recovery process is not constant ($\gamma = 2$) but varies from $\gamma = \infty$ in the beginning of the recovery process to $\gamma = 2$ at the end of the process. (auth)

1545 EFFECTIVE CROSS SECTIONS OF ATOMIC DISPLACEMENT IN SOME TWO-COMPONENT GLASSES UNDER THE EFFECTS OF γ RADIATION. Nesterov, V. M. (Siberian Physical-Technical Inst., Tomsk). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 87-90(1968). (In Russian).

The theoretical values of the effective cross section for the formation of defects as a result of atomic displacement induced by γ radiation at 1.25 MeV were calculated for the following glass systems: Na_2O-SiO_2, K_2O-SiO_2, Na_2O-TeO_2, Cs_2O-TeO_2, $V_2O_5-TeO_2$, and WO_3-TeO_2. (tr-auth)

1546 GRUPPENTHEORIE IN DER FESTKOERPERPHYSIK. (Group Theory in Solid-State Physics). Streitwolf, Hans-Waldemar. Leipzig, Akademische Verlagsgesellschaft Geest and Portig K.-G., 1967. 222p.

The principles of the group theory and the representation theory of finite groups are briefly developed. After a description of the space groups, their properties, and the derivation of their irreducible representations, the application of the group-theory method in quantum mechanics is shown generally. Applications to solid-state physics are then illustrated. The effect of the symmetry on the solutions of the eigenvalue problems of the single electron Hamilton operator with crystal symmetrical potential is first investigated. The spin–orbit coupling and time-reversal symmetry are considered. The lattice oscillations are classified by group theory methods. Selection rules for electron transitions, caused by electron–phonon interaction and by interaction of the electrons with electromagnetic radiation are derived. Selection rules for lattice absorption and for the Raman effect are given. (tr-auth)

1547 ELECTRON BOMBARDMENT EFFECT ON RADIOINDUCED CONDUCTIVITY OF SILICON. Abroyan, I. A.; Tsekhnovicher, L. A. Fiz. Tekh. Poluprov., 2: 1221-3(Aug. 1968). (In Russian).

Experiments with 0.5- to 3-mm specimens of n-Si with $\rho = 40$ ohm · cm and p-Si with $\rho = 1.5$ to 2 kohm · cm bombarded by 1- to 5-keV electron beams revealed two mechanisms of radioinduced conductivity in silicon. One induced reversible and the other irreversible changes in the signal. Irradiation of the silicon surface results in specimen activation which after the primary current cutoff becomes deactivated. However, after the electron bombardment, it does not return to its original state but acquires a new state with a smaller response to radioinduced conductivity. Considering that electrons of 1 to 5 keV do not produce defects in the crystal, the change in the radioinduced conductivity signal must be related to the changes on the surface. Comparatively fast changes in signals during electron bombardment result from the charge and recharge of the surface state (reversible process) while the slow irreversible drop of the signal, during electron beam bombardment, must be due to water desorption or impurities which result in new surface recombinations. (R.V.J.)

1548 HIGH-RESISTANCE AREAS IN SILICON IRRADIATED WITH DEUTERONS AND α PARTICLES. Kolomenskaya, T. I.; Kumakhov, M. A.; Bulgakov, Yu. V. Fiz. Tekh. Poluprov., 2: 1206-7(Aug. 1968). (In Russian).

Spatial distribution of resistivity of silicon irradiated with 12-MeV deuterons and 25-MeV α particles was investigated. The curves showing resistivity of irradiated n- and p-type specimens as functions of dose and distance from source are analyzed. It is shown that for a monoenergetic 25-MeV α-particle beam the curve of the rate of defect development as a function of the particle trajectory in the silicon had a peak halfwidth at the end of the path equal to 7 μ, with an important contribution from straggling. The curve width of resistance at the end of α particle path was found to be ~20 μ which is smaller than that obtained for the deuterons and, in previous works, for protons. (R.V.J.)

1549 RELATIVE INFLUENCE OF A AND E CENTERS ON ELECTRICAL PROPERTIES OF SILICON DURING IRRADIATION. Makarevich, A. I.; Raines, L. Yu. (Minsk Inst. of Solids and Semiconductors). Fiz. Tekh. Poluprov., 2: 1177-9(Aug. 1968). (In Russian).

Curves were constructed for basic current carrier concentration in specimens of varying resistivities during fast neutron bombardment at 50°C of n-type silicon specimens alloyed with phosphorus. Graphical data obtained for the Fermi level (determined by the concentration of current carriers) as a function of the integral fast neutron flux are given for four specimens with various phosphorus contents. The geometry of the curves indicates the various influences of the A centers (oxygen vacancy complexes) and the E centers (phosphorus vacancy complexes) at various stages of continuous irradiation. (R.V.J.)

1550 STABILITY OF COLOR CENTERS IN MIXED KCl–KBr CRYSTALS. Zavadovskaya, E. K.; Annenkov, Yu. M.; Frangulyan, T. S. Opt. Spectrosc. (USSR) (Engl. Transl.), 24: 509-11(June 1968).

Translated from Opt. Spektrosk., 24: 948-51(June 1968).

A study has been made of the thermal stability of color centers in KCl–KBr solid solutions by the method of thermoluminescent thermal bleaching, and also the stability of F centers upon excitation of colored crystals with F light. It has been shown that in the thermal bleaching of crystals, the temperature at which the luminescence and the F-center decay rate are maximum changes as a function of the composition of the KCl–KBr solid solution. A correlation is found between the thermal stability of F centers and the number of free current carriers (cation vacancies) which confirms the involvement of ionic processes in F-center destruction. Upon exposing a crystal to light corresponding to the F-band maximum, F centers are destroyed more efficiently in solid solutions than in KCl and KBr crystals, which might possibly be due to a closer spacing of electron-hole color centers. (auth)

1551 NITROGEN-ION IMPLANTATION ON p-SILICON IN THE ENERGY RANGE BETWEEN 20 AND 215 keV. Cianfrone, F. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Fasoli, U.; Mazzoldi, P. Nuovo Cim., 57B: 534-8(Oct. 11, 1968).

Preliminary results are given on systematic work performed on N-ion implantation, in the energy range from 18 to 215 keV. The ions were accelerated in a 200-keV electrostatic accelerator. An electron suppressor was situated in front of the bombarded specimens in order to avoid emission of secondary electrons. The ion source was a common radio-frequency source fed with nitrogen gas 99.999% pure. It is seen that the molecular ion fraction is of the same order of magnitude as the atomic ions. No

multiply charged ions are present. There are some impurities of hydrogen and oxygen. (M.O.W.)

1552 CONDUCTIVITY CHARACTER OF RARE-EARTH COMPOUNDS. Hulliger, F. (Cyanamid European Research Inst., Geneva). Helv. Phys. Acta, 41: 945-54(Oct. 20, 1968).

The conductivity type of the rare-earth compounds is correlated with the electronic configuration of the cations. Simple halides, chalcogenides, pnictides as well as dihydrides, dicarbides, and hexaborides are briefly discussed. (auth)

1553 THE X-RAY CRYSTAL STRUCTURE DETERMINATION OF $Fe_3(CO)_{11}P(C_6H_5)_3$ AND THE DESIGN, INSTALLATION, AND AUTOMATION OF A NEUTRON DIFFRACTION SYSTEM. Dahm, Donald James. Ames, Iowa, Iowa State Univ., 1968. 86p.

Thesis.

The crystal structure of $Fe_3(CO)_{11}P(C_6H_5)_3$ has been determined from three dimensional x-ray data. Sixteen molecules crystallize in the monoclinic space group $C_{2/c}$ with a = 37.14, b = 12.26, c = 26.05 A, and β = 93.96°. The structure was refined by full matrix least squares with iron and phosphorus atoms anisotropic to a conventional R value of 0.082 for 1800 reflections collected by counter methods. The structure is similar to that of $Fe_3(CO)_{12}$. The iron atoms form a nearly isosceles triangle with the short side connected by two asymmetric carbonyl bridges. The rest of the carbonyls are terminal. Each asymmetric unit contains two molecules which are structural isomers of one another, with the $P(C_6H_5)_3$ group attached to different iron atoms. On the basis of a qualitative m.o. treatment, a lengthening of iron–iron bonds in $Fe_3(CO)_{11}P(C_6H_5)_3$ as compared to $Fe_3(CO)_{12}$ is rationalized as being due to increased population of antibonding orbitals. A Hilger–Watts four-circle neutron diffractometer operates under the control of an SDS-910 computer. The interfacing and programming for the system are of local origin. A neutron beam forming an angle of 90° with the incident beam is taken from a beryllium monochromating crystal located inside the reactor face. Alignment of the diffractometer, both optically and with neutrons, the neutron detection devices, and other aspects of the system are discussed in some detail. (Diss. Abstr.)

1554 ULTRASONIC DETECTION OF THE MIGRATION OF POINT DEFECTS IN LEAD. Woo, Dae-Shik. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 159p.

The migration of point defects in single-crystal samples of 99.999% pure lead has been detected by ultrasonic attenuation. The defects were produced by Co^{60} gamma rays at liquid nitrogen temperature. In the irradiated specimen, isochronal anneals to 270°K produced attenuation minima at 160 and 230°K, whereas the unirradiated specimen had a minimum only at 220°K. A series of isothermal anneals was performed to obtain the energy of migration. The results are interpreted by Granato–Lücke theory by assuming that the point defects produced pin the dislocation. The identification of the migrating defects is guided by the much more extensive work on copper. In lead, interstitials trapped by impurity atoms migrate in the temperature range between 130 and 160°K, free vacancies migrate between 180 and 230°K, and recrystallization occurs between 230°K. The binding energy of interstitials to impurity is 0.15 ± 0.01 eV, the energy of migration of vacancy is 0.36 ± 0.05 eV. The ranges of the recovery stages correspond to stage III and stage IV in copper, when the difference in melting points is taken into account. The migration of point defects in the unirradiated specimen was also observed. These are due to impurity atoms, possibly copper, which boil off from dislocation while warming the crystal to a substantially higher temperature at which recrystallization occurs. The entropy of formation of a vacancy is found to be $S_f^v \simeq 2.1$ k, and the average loop length of the dislocation network is $l_0 \geq 10^{-5}$ cm. A model for defect migration in lead is proposed. It is assumed that a gamma ray penetrates the crystal and creates a Frenkel pair by a Compton electron process. The defects diffuse to dislocation by a random walk process. Once the defect is on the dislocation segment it migrates along the dislocation by a unit jump process and during this process it may jump back to the lattice or migrate along the dislocation in a random fashion and possibly collide with a trap. From trap, it may be emitted back to the dislocation. In this model it is assumed that defects on the dislocation must be in thermal equilibrium with the defects in the lattice next to the dislocation line and also with defects in the traps at the end of the lines satisfying the ordinary Boltzmann distribution. (Diss. Abstr.)

1555 PHOTOCONDUCTIVITY INCLUDING STRESS-INDUCED DICHROISM OF DEFECTS IN SILICON. Kalma, Arne Haerter. Troy, N. Y., Rennsselaer Polytechnic Inst., 1968. 147p.

A new technique of using stress-induced reorientation of defect configurations in crystals and subsequent measurement of the photoconductivity spectra with polarized light is developed. This technique is applied to study defects in electron-irradiated, n-type silicon and it is shown that a measurable dichroism can result from a "normal" photoconductivity transition where the initial state is a defect state and the final state is a carrier band. The annealing behavior and the uniaxial stress response of the 1.5-MeV electron-irradiation-induced defects causing the E_c-0.39 eV and the E_c-0.54 eV energy levels is studied. The results suggest that these two levels arise from the same defect in different charge states. This defect has an atomic symmetry around a ⟨111⟩ direction and a transition dipole along a ⟨110⟩ direction as determined from the electronic redistribution and the atomic redistribution among the allowed configurations. The activation energy for the annealing of the E_c-0.39 eV level is 1.25 eV. Correlating these results with those of previous electron paramagnetic resonance studies and infrared absorption studies leads to the conclusion that the defect in question is the divacancy. Experimental results concerning the properties of the divacancy are compared with theoretical calculations of the divacancy defect states made using both energy band and linear combination of atomic orbitals treatments. The dominant defect photoconductivity observed in 50-MeV electron-irradiated silicon is found to be an "energy band" that extends from the band edge down to an energy of ~0.3 eV. The appearance and annealing behavior of this "energy band" closely resembles what has been termed "near-edge absorption" observed in infrared absorption studies. Single levels are superimposed on top of this "energy band" but form only a small fraction of the defect photoconductivity. The dominant defect photoconductivity observed in 1.5-MeV electron-irradiated silicon is found to be single levels and the "energy band" is much smaller in both magnitude and extent, extending only down to ~0.8 eV. An explanation of this "energy band" as arising from disorder produced by the radiation is offered. (Diss. Abstr.)

1556 EFFECT OF QUENCHING ON THE ROOM-TEMPERATURE F-COLORING OF NaCl. Sanchez, C.; Agullo-Lopez, F. (Junta de Energia Nuclear, Madrid). An. Fis., 64: 121-6 (Mar.-Apr. 1968).

NaCl single crystals quenched from temperatures in the range 300 to 710°C were irradiated with x and γ rays at room temperature. It has been found that for crystals quenched from 710°C, the F-center growth curve does not present any of the three stages appearing in the untreated crystals, since the slope decreases monotonically with dose. On the other hand, for quenching temperatures lower than 480°C, all three stages are present. For intermediate temperatures, the differentiation between the stages is gradually lost. Also, for temperatures higher than a threshold near 450°C, the F coloring appreciably increases in the range of dose corresponding to stages I and II of untreated crystals. The increase in coloration can be attributed to thermal creation of vacancies. As to stage III of crystals quenched from temperatures lower than 480°C, it has been observed that the slope decreases monotonically with quenching temperature. Furthermore, on increasing temperature, the inflection corresponding to the transition from stage II to stage III becomes progressively smoother. Finally, for even higher temperatures, the inflection disappears such as indicated above for the curve corresponding to 710°C. From the experimental data, it can be also inferred that dislocation density in the approximate range 9×10^5 to 6×10^6 cm^{-2} does not influence F-coloring rates during stage I. However, it might be responsible for the decrease in the slope of stage III. (auth)

1557 ULTRASONIC ATTENUATION IN THE NORMAL STATE OF HIGH-PURITY THALLIUM. Willard, H. J. Jr. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Rev., 175: 367-72(Nov. 10, 1968).

The normal-state electronic attenuation of longitudinal ultrasonic waves (10 to 130 MHz) has been studied in high-purity thallium. The attenuation is in general agreement with the Pippard real-metal theory, but does not agree with the free-electron theory. The attenuation is highly anisotropic, in part because of anisotropies in the electron mean free path, the total curvature of the Fermi surface, and the product of the curvature and the Pippard deformation parameter. The electron mean free path was determined from the acoustic measurements for q ||[0001], H ||[10$\bar{1}$0] and q ||[$\bar{1}$2$\bar{1}$0], H ||[10$\bar{1}$0]. The results indicate that the anisotropy in the electron mean free path is due to impurity scattering. The phonon scattering contribution was proportional to T^{-b}, where b = 3.6 ± 0.1 for both directions, whereas b = 5 has been reported from electrical resistivity measurements. A frequency-dependent component of the electronic attenuation was observed for q ||[0001] which could not be explained on the basis of the Pippard theories. (auth)

1558 CHANNELING IN ZINC-BLENDE LATTICES: ENERGY-LOSS STUDIES FOR HYDROGEN AND HELIUM IONS IN InAs, GaSb, AlSb, AND InSb. Sattler, Allan R.; Vook, Frederick L. (Sandia Corp., Albuquerque, N. Mex.). Phys. Rev., 175: 526-32(Nov. 10, 1968).

The energy losses of ions channeled in InAs, GaSb, AlSb, and

InSb were investigated. The average number of electrons/atom participating in the stopping of channeled particles is about the same for GaSb and InAs. The minimum energy losses along the [111] and [$\bar{1}\bar{1}\bar{1}$] directions were investigated for GaSb and AlSb and were found to be independent of this asymmetry. The lattice parameter has a stronger influence on the minimum energy losses in channeling of zinc-blende compounds than the A or Z of the host-lattice atoms. The Z dependence of incident light ions channeled in a given host lattice is the same as that for normal energy losses. The energy losses of axial channeling were investigated for GaSb and appear to be characterized by the energy losses of the plane having the largest interplanar spacing in the axial intersection. (auth)

1559 EFFECTIVE DENSITY OF PHONON STATES FOR $NdCl_3$ FROM VIBRONIC SPECTRA AND APPLICATIONS TO ION-LATTICE INTERACTIONS. Cohen, E.; Riseberg, L. A.; Moos, H. W. (Johns Hopkins Univ., Baltimore). Phys. Rev., 175: 521-5(Nov. 10, 1968).

An effective density of phonon states of $NdCl_3$ has been extracted from the vibronic spectra accompanying several electronic transitions of Pr^{3+} and Nd^{3+}. The derived $g^*(\omega)$ has a very similar structure for all parent electronic transitions. Anomalies in the vibronic spectra occur for certain optical phonons, and are ascribed to interactions of pairs of Nd^{3+} ions via the phonon field. Use is made of the derived $g^*(\omega)$ in explaining various features of phonon-induced relaxation. (auth)

1560 PRODUCTION OF DIVALENT THULIUM IN CaO AND $SrCl_2$. Abraham, M. M.; Reynolds, R. W.; Boatner, L. A. (Oak Ridge National Lab., Tenn.). Phys. Rev., 175: 485-8(Nov. 10, 1968).

$SrCl_2$ crystals doped with 0.5% $TmCl_3$ were irradiated with either ^{60}Co γ rays or 1.7-MeV electrons at room temperature. At 20 and 4.2°K and at 10 Gc/sec, the electron spin resonance of divalent thulium was observed in sites of cubic symmetry. The ground state is a Γ_7 doublet with $g = 3.428 \pm 0.001$ and $A^{169} = 370.0 \pm 0.3 \times 10^{-4}$ cm^{-1}. The thulium appeared to remain in the divalent state for long periods of time at room temperature. Irradiation at either room temperature or 77°K did not produce divalent thulium in $SrCl_2$ crystals doped with Tm_2O_3. CaO doped with 0.5% Tm_2O_3 was irradiated at 77°K with ^{60}Co γ rays or 1.7-MeV electrons. The ESR of divalent thulium in sites with cubic symmetry was observed at 20 and 4.2°K and at 10 Gc/sec without an intervening warmup. The ground state is a Γ_8 doublet with $g = 2.6155 \pm 0.0005$ and $A^{169} = 285.8 \pm 0.3 \times 10^{-4}$ cm^{-1}. After warming to room temperature and returning to 4.2°K, the thulium resonance signals were no longer observable, indicating that the thulium had reverted to the trivalent state between 77°K and room temperature. In both $SrCl_2$ and CaO, the Tm^{2+} resonance was not observable at 77°K. (auth)

Theoretical Physics

Refer also to abstracts 1248, 1546, 1580, and 1609.

1561 (ANL-7271) BISON: A FORTRAN COMPUTER SYSTEM FOR THE CALCULATION OF ANALYTIC SELF-CONSISTENT-FIELD WAVEFUNCTIONS, PROPERTIES, AND CHARGE DENSITIES FOR DIATOMIC MOLECULES. PART 1. USER'S MANUAL AND GENERAL PROGRAM DESCRIPTION. Wahl, Arnold C.; Bertoncini, P. J.; Kaiser, K.; Land, Robert H. (Argonne National Lab., Ill.). Jan. 1968. Contract W-31-109-eng-38. 125p. Dep. CFSTI.

Techniques and a new computer program developed by the authors for obtaining self-consistent-field (SCF) wave functions and properties [very close to the Hartree–Fock (HF) limit] via the Roothaan Expansion Method for heteropolar or homopolar diatomic molecules containing atoms from rows 1 through 5 of the periodic table are discussed. The computer program, which is written entirely in FORTRAN, evaluates all necessary integrals, performs the SCF procedure and then computes charge-density contours and a variety of molecular properties from the resulting SCF wave function. The limitations on the quantum numbers of the Slater-type orbital (STO) basis are $1 \leq n \leq 8$; $0 \leq l \leq n-1$; $-l \leq m \leq l$; a maximum of $1\frac{1}{2}$ million supermatrix elements are permitted which allows accurate SCF calculations on very large diatomic systems. Typical results of recent extended basis-set calculations for the alkali halide NaCl, which illustrate program usage, are presented. (auth)

1562 (ITF-68-9) ON EXISTENCE OF G-ERGODIC VECTOR STATES. Gachok, V. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1968. 24p. Dep.

A study is made of G-invariant vector states generated by positive-definite functionals over a normed algebra with involution Σ, whose elements are vectors $f = \{f_0, \ldots, f_n(x_1, \ldots, x_n)\}$, $f_n(x_1 \ldots x_n)$ being certain test functions. A topology is introduced in which every functional over Σ is quasianalytical and belongs to the Fock space of distributions. These conditions provide for the existence of measures generating vector states. It is shown that any vector state can be approximated by extremal points (G-ergodic vector-states) of the set of G-invariant vector states in the weak topology. (auth)

1563 (N-68-25754) GUIDING CENTER DRIFTS IN TIME-DEPENDENT MERIDIONAL MAGNETIC FIELDS. Birmingham, Thomas J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). May 1968. 14p. (NASA-TM-X-63229; X-641-68-188). CFSTI.

The problem of a particle trapped in a time-dependent meridional magnetic mirror field and at the same time subjected to a time-dependent perpendicular electric field ($E \cdot B = 0$) is considered. Bounce-averaged guiding-center theory is used to derive expressions for the drift-velocity components. These drift expressions depend in a straightforward fashion on the structures of the magnetic and electric fields, and on the particle charge, kinetic energy, longitudinal invariant, and bounce period. In the special case of a static magnetic field, no electric field, and $J = 0$ particles, the drift equations are integrated and the bounce-averaged guiding-center trajectory obtained. (auth) (STAR)

1564 COMPLETE SOLUTION OF SOME IMPORTANT CASES OF TWO-DIMENSIONAL MAGNETIC FIELDS WITH RECTANGULAR BOUNDARIES. Ciganek, Ladislav (Slovenska Vysoka Skola Technicka, Prague). Acta Tech. CSAV, 13: 68-99(1968).

A complete solution of Schwartz transformation of 13 important cases of two-dimensional magnetic fields with rectangular boundaries is offered. In each case all possible distributions of magnetic potentials were considered and real functions for all sides of the periphery are given together with their graphical representation for suitable ratios of main parameters. Additional equations are offered for calculation of unit permeance $\lambda_{n,m}$ between arbitrary points m, n and for calculation of magnetic induction in an arbitrary point. A solution for most of the presented cases has been published in textbooks and papers, but in no case is the solution complete, containing all sides of the periphery and all possible cases of the distribution of magnetic potentials. Original graphical representation of the transforming function $z = f(w)$ offers further important relations, mentioned in special cases. Most important is the possibility to estimate with required accuracy the region where the field is practically homogeneous. This enables use of presented solutions for more complicated spaces. (auth)

1565 DIAGRAMMATICAL DERIVATION AND REPRESENTATION RAYLEIGH–SCHRÖDINGER PERTURBATION THEORY. Salzman, W. R. (Univ. of Arizona, Tucson). J. Chem. Phys., 49: 3035-40(Oct. 1, 1968).

A method is presented for obtaining the various terms in the Rayleigh–Schrödinger perturbation theory to arbitrary order by means of diagrams. The prescription for obtaining the Nth-order correction to a particular zero-order eigenvector is to construct all diagrams of a certain type and associate an operator with each diagram. The method provides for the easy construction and display of Rayleigh–Schrödinger perturbation-theory corrections. The relationship of the present method to other work is discussed. (auth)

1566 TWO-PARTICLE DENSITY MATRIX FOR COULOMB INTERACTION. Baumgartl, Bruno J. (Univ. of Maryland, College Park). Z. Phys., 217: 24-32(1968).

An integral representation is derived for the density matrix of two particles interacting via a Coulomb potential. In particular this representation yields a simple expression for the exchange term of the Slater sum of two identical particles, which is suitable for numerical calculations. Results are given for several values of the parameter $\xi = e^2/kT\lambda$. (auth)

1567 INFLUENCE OF MEDIUM STRUCTURE ON THE BREMSSTRAHLUNG SPECTRUM. Batyghin, V. V. (Kalinin Polytechnic Inst., Leningrad). Phys. Lett., 28A: 65-6(Oct. 21, 1968).

It is shown that there exists an angular and energy interval, in which bremsstrahlung spectrum in a medium (amorphous as well as crystalline) differs essentially from the Bethe–Heitler monatomic spectrum. (auth)

1568 NOTE ON THE RKKY INTERACTION. Vertogen, G. (Univ. of British Columbia, Vancouver). Phys. Lett., 28A: 49-50(Oct. 21, 1968).

An exactly soluble model is presented for the indirect interaction between two magnetic moments. It is shown that both magnetic

moments do not interact with each other if their relative distance R approximately satisfies $R = n\pi/k_F$ (n = 0, 1, 2, ...). (auth)

1569 GENERALIZATION OF DIRAC'S RELATION BETWEEN THE ELECTRIC AND MAGNETIC CHARGE STRENGTHS. Calkin, M. G. (Dalhousie Univ., Halifax, Nova Scotia). Phys. Lett., 28A: 45(Oct. 21, 1968).

A generalization of Dirac's relation between the electric and magnetic charge strengths invariant under duality transformations is obtained. (auth)

1570 QUANTUM THEORY OF MATTER. SECOND EDITION. Slater, John C. International Series in Pure and Applied Physics. New York, McGraw-Hill Book Company, 1968. 779p. $15.00.

This textbook on quantum mechanics features applications to the electronic structure of atoms, molecules, and solids, beginning with the basic principles and concluding at a level required for research applications. Digital computer applications are included and experimental methods for investigating energy bands in solids are discussed. An extensive bibliography which treats recent work in the various fields of research is included. (M.H.R.)

1571 APPROXIMATION METHODS OF QUANTUM MECHANICS. Migdal, Arkadii Beinusovich; Krainov, Vladimir Pavlovich. NEO Press Technical Translation Series. Ann Arbor, Mich., NEO Press, 1968. 152p. $2.00.

Translated from the Russian by Irene Verona Schensted.

Topics covered are: dimensional and model estimates, various cases of the perturbation theory, and the quasi-classical approximations. The chapter on dimensional and model estimates begins with estimates of derivatives and integrals, methods for the qualitative solution of differential equations, and the consequences which follow from the analyticity of physical quantities. By means of model and dimensional estimates, some fundamental results in quantum mechanics and quantum electrodynamics (energy levels, scattering cross sections, lifetimes of atomic states, and the Lamb shift) are obtained. Various forms of the perturbation theory (perturbation of the boundary conditions, adiabatic perturbations, sudden perturbations, etc.) are studyed. Some problems in quantum mechanics are solved quantitatively and not only in order of magnitude. Finally, a detailed exposition of the quasi-classical approximation is given for three dimensional problem as well as the one dimensional problem (boundary conditions in the one and three dimensional cases, the Thomas–Fermi method, the quasi-classical representation of the spherical harmonics, scattering by a noncentral potential, etc.). (M.H.R.)

1572 QUANTUM MECHANICS. Davydov, Alexandre Sergeevitch. Ann Arbor, Mich., NEO Press, 1966. 682p.

Translated from the Russian by Irene Verona Schensted.

The physical foundations and the mathematical apparatus of the quantum theory of the nonrelativistic and quasi-relativistic (accurate to terms of order v^2/c^2) motion of a single particle in an external field are explained. In particular, the inapplicability of the concept of the relativistic motion of a single particle is shown. The theory of representations, the theory of canonical transformations, and the theory of scattering and of quantum transitions are discussed. A relatively detailed treatment of the theory of systems consisting of identical bosons and fermions is given. The fundamentals of the theory of molecules, the theory of the chemical bond, and the theory of solids are covered. The theory of second quantization as a method of studying systems consisting of a large number of identical particles is discussed at length. In particular, the fundamental ideas of the theories of superconductivity and superfluidity are presented. The main concepts on methods of quantizing the meson field, the electromagnetic field (in the absence of charges) and the electron-positron field are given, without taking into account the divergences and the theory of renormalization. (M.H.R.)

1573 MATRIX REPRESENTATION FOR CALCULATION OF THE SECOND ORDER ABERRATIONS IN PARTICLE OPTICS FOR HOMOGENEOUS AND INHOMOGENEOUS (n = 1) MAGNETIC FIELDS. Suarez, A. A.; Coutinho, F. A. B. An. Acad. Brasil. Cienc., 40: 127-42(June 30, 1968).

In analogy with the geometrical optics, a matrix method has been used to calculate the properties of magnetic deflection systems involving a first-order aberration. That formalism is used here to calculate the elements of a twelve-dimensional matrix, extended to a three-dimensional particle motion close to the central orbit (paraxial orbits), in two special cases: homogeneous and inhomogeneous magnetic fields (n = 1). This calculation was extended for the case of a rotation of the field boundary, neglecting the effects due to fringing fields. (M.H.R.)

1574 NOTE ON THE NUMERICAL SOLUTION OF THE SCHROEDINGER EQUATION FOR BOUND STATES. Viana, Jose David M.; Watanabe, Shigueo (Univ., Sao Paulo, Brazil). An. Acad. Brasil. Cienc., 40: 119-25(June 30, 1968).

An alternative method to the Hodgson's one for determining bound states in a potential well, by solving numerically the Schroedinger equation is discussed. Numerical results are presented for square well and Woods–Saxon central well without and with spin-orbit term. The comparison with Hodgson's method is discussed. (auth)

1575 A FIVE-DIMENSIONAL FIELD THEORY. Holzhauser, Scott. Albuquerque, N. Mex., Univ. of New Mexico, 1968. 83p. Thesis.

The introduction of the fifth dimension to the classical field theory reveals many interesting phenomena, the most important of which is that the fields at the center of a particle remain finite. This fact leads to a finite self-energy for the particle. The fields quickly approach the Coulomb potential as distance from the particle increases. Associated with the particle is a charge density which is a function of r, the charge being "smeared" out over a finite radius and attenuating rapidly for r > a where a is on the order of 10^{-15} meters. The time dependent case is solved also. Here the potential and charge density have different forms, but remain finite on the light cone and reduce to the static form when integrating over the time dimension. The five-dimensional formalism introduces extra Maxwell equations (there are seven in all) and there are additional terms in two of the usual four. These additional terms are source terms which are interpreted as charge and current densities arising due to the creation and annihilation of charge. These currents and charges arise from the field itself and, as contrasted with the usual ρ and $\vec{J}$ terms are not sources "externally controllable." One of the three auxiliary Maxwell equations can be reduced to a conservation law for these field created currents and charges. The additional current term also enters into the conservation of energy equation as a dissipative term, thus reinforcing its interpretation as a current. The five-dimensional field contains only two field invariants, one of which is still the Lagrangian. The invariants, the Lagrangian itself and the Hamiltonian for the field all contain additional terms. The theory is developed from the assumption that the current and potential vectors have five components instead of the usual four, and that there are five space variables. The space metric used is $g_{ik} = \delta_{ik}$ thus covariant and contravariant components of vectors and tensors are equivalent. The basic theory is developed entirely in tensor notation, so the formalism is automatically relativistically invariant. The differential equations are solved via Green's functions in three, four, or five dimensions. These solutions have fairly simple forms in most cases because of the assumed spherical symmetry. (Diss. Abstr.)

1576 SCATTERING OF AN INTENSE ELECTROMAGNETIC WAVE BY UNPOLARIZED NEUTRON TARGET. Baranov, I. G. (Nizhne-Tagil State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 113-15(1968). (In Russian).

A powerful laser beam was used in the investigation of quantum processes in intense electromagnetic waves. The studies were confined to the processes of electro-magnetic wave scattering on neutrons. Equations obtained showed that the probability of the process is a function of the wave frequency. The dependence on the intensity was determined by Bessel's function. It was observed that radiation was not emitted during unpolarized neutron motion in constant crossed fields and that the secondary radiation was not polarized during plane electromagnetic wave scattering on unpolarized neutrons. (R.V.J.)

1577 TRANSFER OF RESONANCE RADIATION IN AN INFINITE MEDIUM. I. Nagirner, D. I.; Ivanov, V. V. Astrophysics (Engl. Transl.), 2: 1-11(Jan.-Mar. 1966).

Translated from Astrofizika, 2: 5-30(1966).

The radiation field of an isotropic point source situated in an infinite homogeneous medium is considered. The principal assumptions are: 1) a two-level atom; 2) total frequency redistribution; 3) isotropic scattering; 4) absence of continuous absorption. An explicit expression is derived for the corresponding source function. The principal functions encountered in problems of resonance radiation transfer are investigated in detail. (auth)

1578 PROBLEM IN NONLINEAR RADIATIVE TRANSFER. Engibaryan, N. B. Astrophysics (Engl. Transl.), 2: 12-14 (Jan.-Mar. 1966).

Translated from Astrofizika, 2: 31-6(1966).

A nonlinear problem of radiative transfer in a plane-parallel layer of finite thickness is considered. The layer consists of atoms of two types: scattering and absorbing. By converting to a real optical depth, the solution of the problem is reduced to solution of a nonlinear integral equation of the Hammerstein type and to the determination of the parameter y_0. (auth)

1579 INSTANTANEOUS PROPAGATION IN QUANTUM SYSTEMS. Galindo, A. (Facultad de Ciencias, Zaragoza, Spain). An. Fis., 64: 141-7(May-June 1968). (In Spanish).

Some general statements concerning the free-time evolution of quantum states with a finite number of localizable particles are established under very mild and natural assumptions on the energy function $\omega(p)$. The instantaneous breakdown of localization of states is first proved and the applicability of van Kampen's classical result on the nonexistence of wave functions with sharp wave fronts is substantially extended. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstract 1783.

1580 (IS–1900, Paper 6) PHYSICS DIVISION. Spedding, F. H.; Zaffarano, D. J.; Barnes, R. G.; (and others) (Ames Lab., Iowa). 87p.

A progress report on the research done by the Physics Division of Ames Laboratory during the period July–1967 to June–1968 is presented. Topics include fundamental particle theory, experimental work with bubble chambers, experimental work with scintillation counters, photonuclear cross sections, photoproton experiments, theoretical nuclear physics, design and development accelerators and electronic devices, nuclear spectroscopy, isotope separators, charged particle physics nuclear theory, electronic properties of metals, electronic structure of crystalline solids, superconductivity, thermodynamic properties of solids, semiconductors and compounds with variable stoichiometry, rare earth metals and rare earth compounds, optical properties of solids, and neutron scattering in solids. (B.G.D.)

Electromagnetic

1581 THE TRANSVERSE AND LONGITUDINAL CROSS SECTIONS FOR ELECTROPRODUCTION OF PIONS NEAR THE Δ(1236)-ISOBAR. Bartel, W.; Dudelzak, B.; Krehbiel, H.; McElroy, J.; Meyer-Berkhout, U.; Schmidt, W.; Walther, V.; Weber, G. (DESY, Hamburg. Univ., Hamburg). Phys. Lett., 27B: 660-2(Oct. 14, 1968).

The reaction $e + p \rightarrow e' + N^*$ was studied for four momentum transfers up to 2.34 $(GeV/c)^2$ in the region of the 1236 MeV isobar. An analysis of the data in terms of the cross sections σ_T and σ_L for the absorption of transverse and longitudinal photons is given for invariant masses of the final pion nucleon system W = 1.220 GeV and W = 1.350 GeV. (auth)

1582 NUCLEAR INTERACTIONS PRODUCED BY HIGH-ENERGY MUONS. Chaudhuri, N. (Univ. of North Bengal, India); Sinha, M. S. Nuovo Cim., 57A: 753-62(Oct. 21, 1968).

Penetrating showers produced in iron plates of a multiplate cloud chamber by muons at 148 mwe underground are analyzed. The events are interpreted by the usual method of virtual quanta due to Williams and Weizsäcker. Cross sections for such events have been determined by using the virtual photon spectrum given by Heitler and also the spectrum calculated by Kessler and Kessler. The observed cross sections for energy transfers in the range (1 to 8) GeV agree with that obtained from the Heitler spectrum with a constant cross section $1.4 \cdot 10^{-28}$ cm^2 per nucleon for interaction of photons with nucleons. Angular distribution of secondary penetrating particles of the observed showers is shown to be given by the projected angular distribution function obtained by Das and Sinha. (auth)

1583 PHOTOPRODUCTION OF CHARGED PION PAIRS FROM HYDROGEN AT PHOTON ENERGIES BETWEEN 800 AND 1500 MeV. Shanks, Wesley Loren. Pasadena, Calif., California Inst. of Tech., 1968. 138p.

Thesis.

The reaction $\gamma + p \rightarrow p + \pi^+ + \pi^-$ has been studied for photon energies between 800 and 1500 MeV and for dipion masses between 510 and 900 MeV. The bremsstrahlung beam from the Caltech synchrotron was passed through a liquid hydrogen target and spark chambers were used to detect the three final particles. In addition, the proton energy was determined by a range measurement. Approximately 40,000 photographs were taken, yielding 3018 acceptable events. The results were fit to an incoherent combination of the N*(1238) resonance, the ρ^0(750) resonance, and three-body phase space, with various models being tried for ρ^0 production. The total cross section for ρ^0 production is consistent with previous experiments. However, the angular dependence of the cross section is slightly more peaked in the forward direction, and the ratio of ρ^0 production to phase space production is larger than previously observed. However, since this experiment was only sensitive to the production angles $\cos\theta$ cm $\geq .75$, statistical fluctuations and/or an anisotropic distribution of background production have a severe influence on the ρ^0 to background ratio. Of the ρ^0 models tested, the results prefer ρ^0 production by the one pion exchange mechanism with a very steep form factor dependence. The values of the mass and width of the ρ^0 found here are consistent with previous experiments. (Diss. Abstr.)

1584 ASSOCIATED PHOTOPRODUCTION OF CHARGED K MESONS AND HYPERONS. Tyson, James David. New Haven, Yale Univ., 1968. 198p.

Thesis.

A search has been made for heavy mass elementary particles produced from hydrogen by gamma rays from the Cambridge Electron Accelerator with energies from 4.0 to 6.0 GeV, according to the reactions $\gamma + p \rightarrow K^+ + Y^{*0}$ and $\gamma + p \rightarrow K^- + Z^{*++}$ where the Y* is uncharged and has strangeness −1 and isotopic spin of 0, 1, or 2. The strangeness +1 Z* must have a charge of +2 and isotopic spin of 1 or 2. The existence of the short-lived Y* or Z* hyperons was deduced by studying the K meson yield. The K mesons were detected by differential gas Čerenkov counters and momentum analyzed by bending magnets and scintillation counters. The spectrometer momentum was kept fixed while the peak energy of the gamma ray beam was varied, and the resulting K meson yield curve was analyzed for evidence of hyperon production according to the above reactions. Photoproduction of Y* states with masses of 1820 MeV, 2025 MeV, 2135 MeV, 2250 MeV, 2360 MeV, and 2530 MeV was observed in the K^+ meson data. The results on the lower mass states are in good agreement with other evidence for Y* states. The 2530 MeV state was first reported on the basis of this experiment. The K^- meson data are interpreted as evidence for production of Z* resonant states, with such states appearing at 1860 MeV, 2130 MeV, and 2280 MeV. The existence of such Z* resonances has not, however, been definitely established. (Diss. Abstr.)

Weak

Refer also to abstract 1796.

1585 (ORO–2504-122) HYPERON LEPTONIC DECAYS. Technical Report No. 839. Sechi-Zorn, B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). June 1968. Contract AT(40-1)-2504. 11p. (CONF-680439–3). Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

New experimental data on hyperon leptonic decay are reviewed and discussed in the framework of the universal V–A Fermi interaction modified by the Cabibbo theory. (L.B.S.)

1586 (UCI–10-P-19-7) RESEARCH PROGRAM IN NEUTRINO PHYSICS, COSMIC RAYS AND ELEMENTARY PARTICLES. Technical Report, October 1, 1967–September 30, 1968. Reines, F. (California Univ., Irvine). July 1968. Contract AT-11-1-GEN-10. 30p. Dep. CFSTI.

A new upper limit has been placed on the neutral lepton current via the reaction $\bar{\nu}_e + d \rightarrow n + p + \bar{\nu}_e$ for which the cross-section is now $< 3 \times 10^{-42}$ cm^2/fission $\bar{\nu}_e$. This constitutes an improvement by a factor of 100 from the previous limit. Muon decays have been observed at moderate and at great depths underground enabling two inferences to be drawn. (1) The results at moderate depths provide independent evidence that the very energetic penetrating component is due to muons and gives a new tool for the study of muon spectra. (2) The results at great depths allow the effective atmospheric neutrino spectra to be inferred as in the general vicinity of 10 GeV. Further study of the background in the solar neutrino scintillation detection has reinforced the earlier suspicion that spontaneous fission gives rise to gamma-rays with energies up to ~20 MeV. This is considerably higher than the ~7 MeV observed by other groups with less sensitive techniques. The equipment for the elastic scattering experiment has been moved to SRP and the process of studying its response there started. At this stage, the background is still ~300 times the expected signal. In South Africa the experimental work on level 76 was completed and moved out of that location into a new laboratory on level 77 where initial installation of the first elements of the conversi flash tube system has now been accomplished. Procurement of the bulk of equipment for the new laboratory is now in the final stages. The status of the search for solar neutrinos has been reviewed with the conclusion that all current approaches other than that of R. Davis of Brookhaven now show very little promise. Studies have been completed which indicate the feasibility of measuring at sea level the interaction of ultra high energy cosmic ray muons (≳1000 GeV) with matter. (auth)

1587 UNDERGROUND SEARCH FOR LEPTONIC QUARKS IN THE COSMIC RADIATION. Briatore, L. (Univ., Turin); Castagnoli, C.; Bollini, D.; Massam, T.; Palmonari, F.; Zichichi, A. Nuovo Cim., 57A: 850-62(Oct. 21, 1968).

The flux of relativistic leptonic particles with charges $\pm e/3$, $\pm 2e/3$, $\pm 4e/3$ in cosmic rays underground at 63 mwe was measured using a six-scintillation-counter telescope. The following upper limits were established: $\varphi(\pm e/3) \leq 1.8 \cdot 10^{-10}$ cm^{-2}sr^{-1}s^{-1}, (90% confidence) $\varphi(\pm 2e/3) \leq 1.8 \cdot 10^{-10}$ cm^{-2}sr^{-1}s^{-1}, (90% confidence) $\varphi(\pm 4e/3) \leq (1.1 \pm 1.8) \cdot 10^{-8}$ cm^{-2}sr^{-1}s^{-1}, at threshold energies of (2.1 ± 0.1) GeV, (8.5 ± 0.6) GeV, (22 ± 1) GeV, respectively. (auth)

1588 MEASUREMENT OF THE BRANCHING RATIOS OF THE DECAY OF THE K^+ MESON. Zeller, Michael Edward. Los Angeles, Univ. of California, 1968. 147p.

Thesis.

A measurement of the rates $K^+ \rightarrow \pi^0 + \pi^+$, $K^+ \rightarrow \mu^+ + \pi^0 + \nu$, and $K^+ \rightarrow e^+ + \pi^0 + \nu$ with respect to $K^+ \rightarrow \mu^+ + \nu$ has been made using a magnetic spectrometer and spark chambers. Both the range and momentum of the charged decay product are observed and compared with a Monte Carlo calculation of these quantities. The decay in flight of the K^+ and scattered pions is rejected by means of a decay time requirement. The possibilities that a large form factor dependence of momentum transfer would cause the $K_{\mu 3}/K_{e3}$ ratio to be strongly affected have been investigated. Such a dependence does not improve the agreement between branching ratio measurements and polarization measurements of the parameter ξ. The results of the branching ratio measurement are $\Gamma(K_{\mu 2}) = (65.0 \pm 0.9)\%$, $\Gamma(K_{e2}) = (19.8 \pm 1.1)\%$, $\Gamma(K_{\mu 3}) = (3.5 \pm 0.6)\%$, and $\Gamma(K_{e3}) = (4.4 \pm 0.4)\%$. These results have been normalized to 100% assuming $\Gamma(\tau) = (5.57 \pm 0.03)\%$ and $\Gamma(\tau') = (1.71 \pm 0.07)\%$. (Diss. Abstr.)

Strong (Baryon-Induced)

Refer also to abstracts 1784 and 1785.

1589 PRODUCTION OF K MESONS IN THREE-BODY STATES IN PROTON–PROTON INTERACTIONS AT 6 BeV/c. Mandelkern, Mark Alan. Berkeley, Calif., Univ. of California, 1967. 84p.

An analysis is presented of data from an exposure of the LRL 72" liquid hydrogen bubble chamber to a 6 GeV/c proton beam. Processing of 9700 events, containing at least one observed neutral or charged decay has yielded 1748 examples of the reaction proton + proton → hyperon + K meson + nucleon. Production cross sections for these three body reactions are: $\sigma(\Lambda K^+p) = 54^{+3}_{-5}$ μb, $\sigma(\Sigma^0K^+p) = 17^{+1}_{-1}$ μb, $\sigma(\Sigma^+K^0p) = 26 \pm 4$ μb, and $\sigma(\Sigma^+K^+n) = 57 \pm 7$ μb. Strong N* production is observed in all channels. In particular one or more $T = 1/2$ resonant states with mass near 1700 MeV/c^2, decaying into ΛK^+, and a $T = 3/2$ resonance with mass 1920 MeV/c^2, decaying into ΣK are produced. The final states ΛpK^+ and Σ^+K^+n are studied in detail. In both cases the data are consistent with a single pion exchange mechanism modified by a form factor and inconsistent with kaon exchange. The remaining two reactions are found qualitatively to have these properties as well. No evidence is found for a dibaryon state in either the Λ-proton or Σ-nucleon system. Cross section relations among three-body final states of pp reactions implied by exact SU_3 symmetry are tested and found to be inconsistent with the data. (auth)

1590 SMALL-ANGLE pd SCATTERING IN THE MOMENTUM RANGE 1.3 TO 1.5 GeV/c. Dutton, L. M. C.; van der Raay, H. B. (Univ. of Birmingham, Eng.). Phys. Rev. Lett., 21: 1416-18 (Nov. 4, 1968).

The elastic and quasielastic scattering of incident protons by a deuterium target, over the angular range 20-70 mrad in the laboratory system, has been determined using a sonic spark-chamber system. Data were obtained at incident momenta of 1.29, 1.39, and 1.54 GeV/c and analyzed to determine the ratio of the real to imaginary parts of the pn forward scattering amplitude. Satisfactory agreement with the predictions of dispersion-relation calculations was obtained. (auth)

Strong (Meson-Induced)

1591 (BNL-12803) RECENT EVIDENCE FOR A CHARGED NONSTRANGE MESON AT ~975 MeV PRODUCED IN K^-p INTERACTIONS AT 4.6 GeV/c. Barnes, V.; Dornan, P.; Guidoni, P.; Samios, N. (Brookhaven National Lab., Upton, N. Y.); Goldberg, M.; Leitner, J. (Syracuse Univ., N. Y.). [nd]. 7p. (CONF-680809-28). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Preliminary results are reported of a study of K^-p interactions at 4.6 GeV/c in the BNL 80-inch hydrogen bubble chamber. A significant enhancement was observed in the (π^-,M) effective mass distribution at ~975 MeV for 2736 $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$ + (neutrals = M) events. Possible decay modes of the X^- via the $(\pi^-$ + neutrals) channel are examined. (L.B.S.)

1592 (BNL-12808) CONFIRMATION OF THE Ξ(1815) AND EVIDENCE FOR A NEW Ξ RESONANCE WITH MASS 2030 MeV. Alitti, J.; Flaminio, E.; Metzger, W.; Radojicic, D.; Rau, R. R.; Richardson, C. R.; Samios, N. P. (Brookhaven National Lab., Upton, N. Y.); Bassano, D.; Goldberg, M.; Leitner, J. (Syracuse Univ., N. Y.). [1968]. 8p. (CONF-680809-27). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Evidence for the existence of the Ξ(1815) and for a new $S = -2$ baryon at a mass of 2030 MeV is obtained from a study of K^-p interactions at 3.9, 4.6, and 5.0 BeV/c in the BNL 80-inch hydrogen bubble chamber. The strong configuration of the 1815 state strengthens previous speculation of the existence of an SU(3) octet having spin and parity $J^P = 3/2^-$. It is postulated that the new baryon belongs to an SU(3) octet with $J^P = 3/2^-$. (L.B.S.)

1593 (JINR-P1-4049) INVESTIGATION OF THE QUASI TWO-PARTICLE REACTIONS IN THE 4.0 GeV/c π^-p-INTERACTIONS WITH STRANGE PARTICLES INVOLVED. Kuznetsov, A. A.; Mel'nikova, N. N.; Chadraa, B.; Boldea, V.; Mikhul, A.; Mumuyanu, D.; Ponta, T.; Felea, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 20p. (In Russian). Dep.

The $\pi^- + p \rightarrow \Lambda^0(\Sigma^0) + K^0$ and $\pi^- + p \rightarrow \Lambda^0(\Sigma^0) + K^{*0}(890)$ reactions in 4.0 GeV/c π^-p-interactions have been investigated. The experimental data on the total and differential cross sections of these processes are given. Production and the decay properties of the K*(890) resonance in the YKπ final states have been investigated. The elements of the matrix density have been calculated and the data have been analyzed within the peripheral model with the account of the absorption and the Regge pole model. (auth)

1594 (JINR–E2-4064) ON THE NECESSITY OF NEW MEASUREMENTS OF THE SPIN PARITY OF $X^0(960)$-MESON. Zaslavskii, A. N.; Ogievetskii, V. I.; Tybor, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 14p. Dep.

It is shown that contrary to the widespread opinion, it is impossible to assert, basing on the available experimental data, that the X^0–meson is a pseudoscalar, the spin-parity 2- seems to be even more preferable. In this case the nonet of pseudoscalar mesons would contain an E^0 (1420)-meson according to the prediction of broken $SU(6)_w$. A method is suggested for solving the alternative 2^- or 0^- for the X^0-meson by measuring both the width of the two-photon X^0-meson decay and the X^0 production cross section in the Primakoff effect. (auth)

1595 (KFKI–26/1968) ON T'IE AZIMUTHAL EFFECTS OF TWO PRONG πN AND THREE PRONG DD EVENTS PRODUCED BY 17.2-GeV/c π^- MESONS. Bozoki, G.; Gombosi, E.; Suranyi, G. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1968. 21p. Dep.

A deviation from isotropy in the azimuthal angular distribution of secondary particles of two and three prong pion-nucleon interactions is observed in emulsion at 17.2 GeV/c. Attempts are made using Monte Carlo calculations for the interpretation of these azimuthal effects on the basis of the kinematics of reactions $\pi^- p \rightarrow p\pi^-(k\pi^0)$ and $\pi^- p \rightarrow n\pi^+ \pi^-(k'\pi^0)$ and the diffraction dissociation of pions on nuclei. A new method is given for the selection of the contribution of DD interactions from the three prong events. Using this method $\lambda_{DD} = (1065 \pm 288)$m and $\lambda_{DD} = (113 \pm 13)$m are obtained for the mean free path of the diffraction dissociation in emulsion at ~7 and 17.2 GeV/c, respectively. The possible influence of the Deck-effect in case of the three prong events is also investigated. (auth)

1596 SEARCH FOR NEW MESON RESONANCES IN K^+p INTERACTIONS AT 12.7 GeV/c. Berlinghieri, J. C.; Farber, M. S.; Ferbel, T.; Forman, B. E.; Melissinos, A. C.; Slattery, P. F.; Yamanouchi, T.; Yuta, H. (Univ. of Rochester, N. Y.). Phys. Lett., 27B: 665-8(Oct. 14, 1968).

In a study of K^+p interactions at 12.7 GeV/c a search was carried out for meson resonances having any one of the following properties: (a) a strangeness of $S = 2$, (b) $S = 1$ and isotopic spin of $I = 3/2$, or (c) $S = 1$, $I = 1/2$ and decaying into an antihyperon ($\bar{Y}$) and a nucleon (N). (auth)

1597 OBSERVATION OF THE pπ DECAY MODE OF THE $N^*_\eta(1400)$ RESONANCE IN pp INTERACTIONS AT 22 GeV/c. Jespersen, R. A.; Kang, Y. W.; Kernan, W. J.; Leacock, R. A.; Rhode, J. I.; Schalk, T. L.; Schroeder, L. S. (Iowa State Univ., Ames). Phys. Rev. Lett., 21: 1368-71(Oct. 28, 1968).

Approximately 12,000 four-pronged interactions of 22-GeV/c protons in a hydrogen bubble chamber were measured. In a sample

of 1234 $pp\pi^+\pi^-$ events the final state is dominated by $\Delta^{++}(1236)$ production. Approximately 120 of these events are attributed to the $p\pi^+\pi^-$ decay of a resonant state with mass 1443 ± 15 MeV and with 100 ± 25 MeV identified with the $N^*_\eta(1400)$ resonance. There is also strong evidence for a $p\pi\pi$ enhancement with a central mass value of 1693 MeV. (auth)

1598 EVIDENCE FOR A $\Lambda\pi$ ENHANCEMENT NEAR $\bar{K}N$ THRESHOLD. Cline, D.; Laumann, R.; Mapp, J. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 21: 1372-5(Oct. 28, 1968). (COO-881-164).

A strong enhancement is observed in the $\Lambda\pi^-$ mass spectrum in the reaction $K^-d \rightarrow \Lambda\pi^-p$; the central mass of the enhancement is at 1440 MeV, near $\bar{K}N$ threshold. The enhancement may be explained in one of two ways: (1) as being due to a "moving triangle singularity", or (2) as being due to an I = 1 resonance strongly coupled to the $\Lambda\pi$ system. (auth)

1599 A STUDY OF FINAL STATES CONTAINING A Λ^0 PRODUCED IN π^-p INTERACTIONS AT 5.95 BeV/c. Small, Timothy Michael. Bloomington, Ind., Indiana Univ., 1968. 146p.

Thesis.

A study of the characteristics of final states of the type $\Lambda K + (n\pi)$, n = 0, 1, . . . , 4 is presented. These final states were produced in the interactions of a π^- beam of 5.95 GeV/c momentum with protons in a liquid hydrogen bubble chamber at the ZGS facilities at Argonne National Laboratory. An exposure of 2.8 events per microbarn resulted in a population of approximately ten to eighty events in each final state analyzed. The partial cross sections for production of the separable final states are presented and compared to that obtained at other energies. $\Lambda K\pi\pi$ and $\Lambda K\pi\pi\pi$ final states are the most copiously produced in these data with typical cross sections of 100 microbarns. The Λ^0 center-of-mass angular distributions for all final states are strongly peaked in the backward direction indicative of a peripheral interaction which has been described in terms of a one meson exchange model. The quasi-two-body production predicted by this model is compared to that observed in the data. In the $\Lambda^0K^+\pi^-$ final state strong $K^{*0}(890)$ production and a lack of $Y_1^{*-}(1385)$ production is observed; this is predicted by a one meson exchange mechanism. The quasi-two-body $Y_1^{*0}(1385)$ $K^{*0}(890)$ channel is observed in the $\Lambda^0K^+\pi^-\pi^0$ final state, while the $Y_1^{*-}(1385)$ $K^{*+}(890)$ channel is not present; this also is consistent with a one meson exchange process. The two- and three-body effective-mass distributions are displayed. The resonance production observed in these distributions is compared to that reported at other energies in order to establish the energy dependence of the resonance production. (Disser. Abstr.)

1600 π^+ DECAY OF A $^7Be_\Lambda$ OR $^9B_\Lambda$ HYPERNUCLEUS. Phillips, R. E.; Schneps, J. (Tufts Univ., Medford, Mass.). Nuovo Cim., 57A: 879-80(Oct. 21, 1968).

An example of a 3-prong π^+ decay of an hypernucleus was observed in K^- interactions in nuclear emulsions at 1.1 GeV/c. The interpretations given to fit this event are the following: $_\Lambda Be^7 \rightarrow \pi^+ + {}^3H + {}^4He + n$, $_\Lambda B^9 \rightarrow \pi^+ + {}^1H + {}^6Li + 2n$, and $_\Lambda B^9 \rightarrow \pi^+ + {}^2H + {}^6Li + n$. (L.B.S.)

1601 STUDY OF $\pi^-\pi^-$ ELASTIC SCATTERING IN THE REACTION $\pi^-p \rightarrow N^{*++}\pi^-\pi^-$ AT 11 GeV/c. Caso, C. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa); Conte, F.; Tomasini, G.; (and others). Nuovo Cim., 57A: 699-711(Oct. 21, 1968).

Experimental data are presented on the reaction $\pi^-p \rightarrow N^{*++}\pi^-\pi^-$. For events with low momentum transfers ($\Delta^2 < 0.3$ (GeV/c)^2) the nonresonant background in the N^{*++} region is about 19%. Applying different versions of the OPE model, values are obtained for the elastic $\pi^-\pi^-$ cross section for energies of the $\pi\pi$ system up to 1.72 GeV. Distributions of the $\pi\pi$ scattering angle are shown for different regions of the $\pi^-\pi^-$ energy. (auth)

1602 PARTIAL-WAVE ANALYSIS OF THE SEQUENTIAL REACTION $K^-N \rightarrow Y_1^*(1385)\pi \rightarrow \Lambda\pi\pi$ IN THE CENTER-OF-MASS ENERGY RANGE 1600 to 1740 MeV. Sims, W. H. (Florida State Univ., Tallahassee); Albright, J. R.; Brucker, E. B.; (and others). Phys. Rev. Lett., 21: 1413-16(Nov. 4, 1968).

The reaction $K^-n \rightarrow \Lambda\pi^-\pi^0$ for c.m. energies from 1600 to 1740 MeV is found to proceed entirely through the two-body $Y_1^*(1385)\pi$ state. A partial-wave analysis of the $Y_1^*(1385)\pi$ state implies s-channel production of $Y_1^*(1600)$, $Y_1^*(1765)$, and a $Y_1^*(1700)$ with the subsequent decay of each into $Y_1^*(1385)\pi$. A determination of the mass, width, elasticity parameter, spin, and parity of each of these s-channel resonant states has been made. (auth)

1603 MEASUREMENTS OF THE POLARIZATION IN π^+p ELASTIC SCATTERING AT 5.15 GeV/c. Esterling, R. J. (Univ. of Chicago, Ill.); Booth, N. E.; Conforto, G.; Parry, J.; Scheid, J.; Sherden, D.; Yokosawa, A. Phys. Rev. Lett., 21: 1310-13(Nov. 4, 1968).

Results obtained at the zero-gradient synchrotron for the polarization in π^+p and π^-p elastic scattering at 5.15 GeV/c, from $-t$ = 0.2 to 2.0 (GeV/c)^2 are reported. The results may be qualitatively understood on the basis of a simple Regge-pole model. In addition to the flip amplitude due to ρ exchange, a significant I = 0 flip amplitude is required. (auth)

1604 K^+p ELASTIC SCATTERING IN THE BACKWARD DIRECTION AT 2.76 GeV/c. Abrams, G. S.; Eisenstein, L.; O'Halloran, T. A. Jr.; Shufeldt, W.; Whitmore, J. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 21: 1407-9(Nov. 4, 1968).

The differential cross section for backward ($\cos\theta^* \leq -0.84$) K^+p elastic scattering has been measured at 2.76 GeV/c. No evidence is seen for the $Z_1(2505)$ or for a dip in $d\sigma/du$ at 180°. A good fit with an exponential in $\cos\theta^*$ is obtained, yielding a slope 13.0 ± 2.4 and an intercept $d\sigma/d\Omega(180°) = 87 \pm 16$ μb/sr. (auth)

1605 ASSOCIATED RESONANCE PRODUCTION IN π^-p INTERACTIONS AT 6 GeV/c. Alyea, E. D. Jr.; Crittenden, R. R.; Galloway, K. F.; Lee, K. Y.; Martin, H. J.; Suen, K. F. (Indiana Univ., Bloomington). Phys. Rev. Lett., 21: 1421-3(Nov. 4, 1968).

Results are presented to show that resonance production occurs in a significant fraction (>50%) of the multipion final states with four or more outgoing pions. The data also indicate that the $\Delta(1236)$ nucleon isobar is normally associated with ρ and ω mesons in production. A large proportion of the ρ and ω mesons observed in the multipion final states is the decay products of higher mass enhancements (A_1,A_2,B). (auth)

Particle Interactions and Properties (Theoretical)

General

1606 THE DYNAMICS OF ELEMENTARY PARTICLES AND THE PION–NUCLEON INTERACTION. Course B. Lectures Given at The Niels Bohr Institute and NORDITA, Copenhagen. Hamilton, J. Copenhagen, NORDITA, 1968. 283p. (NP-17652).

Anomalous thresholds, analytic properties of Schrödinger's wave function, the Landau-Bjorken-Cutkosky rules for finding the singularities in field theoretical problems, the unitarity relation, the application of time reversal, and the ellipse of convergence of a Legendre series are studied. Two main applications, a forward dispersion relation for charge exchange pion-nucleon scattering which does not assume charge independence and the principles and main arguments involved in setting up and using partial wave dispersion relations for pion-nucleon scattering are considered. These notes are not primarily concerned with the results and physical interpretation of this partial wave π-N analysis. (auth)

1607 LIMITABLE DYNAMICAL GROUPS IN QUANTUM MECHANICS. I. GENERAL THEORY AND A SPINLESS MODEL. Doebner, H. D.; Melsheimer, O. (International Atomic Energy Agency, Trieste, Italy). J. Math. Phys. (N. Y.), 9: 1638-56 (Oct. 1968).

A pure group-theoretical description of nonrelativistic interacting systems in terms of irreducible representations U(D) of a so-called dynamical group D is investigated. The description is assumed to be complete in the sense that all observable quantities of the system can be calculated from U(D) in the same way as the nonrelativistic free particle can be identified with an irreducible representation $U(G_E)$ of the central extension of the inhomogeneous Galilei group G_E. D depends on the interaction. It is a noninvariance group and it contains a spectrum-generating algebra. Our problem is to connect a representation of an arbitrary abstract group with a complete description of an interacting system. This needs some physically motivated principles. Some such principles are proposed. We assume that the interaction can be turned off, which implies that U(D) and the physical representation $U(G_E)$ of the free-particle group G_E can be limited into each other. If this limitation can be formulated without violating superselection rules, i.e., mass and spin conservation in nonrelativistic systems, the group D^t is called a limitable group. Properties of these groups are derived. An explicit construction of a limitable D^t is given by embedding the free-particle group G_E into a larger group. A discussion of all embeddings leads to the special choice $D^t \approx G_E^0(N) \times Sp(2N,R)$. $G_E^0(N)$ is the central extension of the pure inhomogeneous Galilei group in N dimensions and Sp(2N,R) the noncompact real form of the symplectic group. A representation theory for D^t is established using the technique of Nelson extensions, together with some properties of the universal enveloping algebra of the Lie algebra of $G_E^0(N)$. Our main success is that D^t is a limitable dynamical group and that the physical system described by D^t and the physical representation can be calculated uniquely from the

proposed principles. The group-theoretical description is equivalent to nonrelativistic quantum mechanics for a spinless particle in N dimensions with an arbitrary second-order polynomial in P_i, Q_i, $i = 1, \ldots, N$ as Hamiltonian. The possibility of further models is discussed. (auth)

1608 POINCARE GROUP AND THE INVARIANT RELATIVISTIC EQUATIONS FOR MASSIVE PARTICLES OF ANY SPIN. de Azcarraga, Jose A.; Boya, Luis J. (Instituto de Fisica Teorica, Barcelona). J. Math. Phys. (N. Y.), 9: 1689-93(Oct. 1968).

An attempt is made to clarify some aspects of the connection between the Poincaré group and the invariant equations for nonzero-mass particles of any spin (Bargmann–Wigner equations). With this purpose some general considerations about the representations of the Poincaré group are made and the equivalence between the realizations corresponding to a given class and a selected "canonical" one which was given by Wigner is analyzed. For the spin-$\frac{1}{2}$ case the equivalence is given by the Chakrabarti transformation, and for higher spins a generalization of it is introduced; also the case $S = 1$ is considered specifically. The form of the equations which provide the corresponding canonical realization is given; some comments about the equivalence of the theories provided by the different realizations are also made. (auth)

1609 POSSIBLE KINEMATICS. Bacry, Henri (Inst. for Advanced Study, Princeton, N. J.); Levy-Leblond, Jean-Marc. J. Math. Phys. (N. Y.), 9: 1605-14(Oct. 1968).

The kinematical groups are classified; they include, besides space–time translations and spatial rotations, "inertial transformations" connecting different inertial frames of reference. When parity and time-reversal are required to be automorphisms of the groups, and when a weak hypothesis on causality is made, the only possible groups are found to consist of the de Sitter groups and their rotation-invariant contractions. The scheme of the contractions connecting these groups enables one to discuss their physical meaning. Beside the de Sitter, Poincaré, and Galilei groups, two types of groups are found to present some interest. The "static group" applies to the static models, with infinitely massive particles. The other type, halfway between the de Sitter and the Galilei groups, contains two nonrelativistic cosmological groups describing a nonrelativistic curved space–time. (auth)

1610 TEST OF THE EQUIVALENCE PRINCIPLE FOR UNSTABLE ELEMENTARY PARTICLES. Beall, E. F. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 1364-7(Oct. 28, 1968).

It is argued that a sufficiently fast, charged, nongravitating particle would radiate strongly in a classical gravitational field. Subject to some assumptions, the possibility that the muon does not couple to gravitation is ruled out on the basis of existing data. (auth)

Electromagnetic

Refer also to abstracts 1157, 1624, 1643, and 1787.

1611 HARD MESON ANALYSIS OF PHOTON DECAYS OF π^0, η, AND VECTOR MESONS. Arnowitt, R.; Friedman, M. H.; Nath, P. (Northeastern Univ., Boston). Phys. Lett., 27B: 657-9(Oct. 14, 1968).

A simple derivation of the hard meson result that PCAC and CVC forbid π^0, η and vector meson two body, photon decays is given. A model of PCAC breakdown which permits these decays is proposed. The modified PCAC is in agreement with the photon decay data and does not disturb the previous successes of PCAC. (auth)

1612 ALGEBRA GENERATED BY MOMENTS OF CURRENT AND THE ELECTROMAGNETIC STRUCTURE OF THE NUCLEON. Hanawa, Sigeo (Tokyo Gakugei Univ.). Bull. Tokyo Gakugei Univ., Ser. 4, 19: 1-5(Aug. 1967).

The relations $\langle r^2_{Mp}\rangle = \langle r^2_{Ep}\rangle + (\mu_n/\mu_p)\langle r^2_{En}\rangle$ and $\langle r^2_{Mn}\rangle = \langle r^2_{Ep}\rangle + [1 + (\mu_p/\mu_n)]\langle r^2_{En}\rangle$ were derived from the algebra generated by the magnetic moment, the second order moment of its density, and that of the electric charge density with the use of Lee's method. It is assumed that the matrix elements of the commutator algebra between zero momentum octet baryons are saturated by intermediate octet and douplet states; as for the dynamics of strong interactions, only the SU(3) symmetry is assumed. (auth)

1613 STRAGGLING DISTRIBUTIONS OF EXTREMELY LARGE ENERGY LOSSES. Tschalar, C. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Instrum. Methods, 64: 237-43(Oct. 1968).

Previous calculations of straggling distributions of heavy particles traveling through a homogeneous absorber based on expansions into higher moments are reexamined. They are shown to break down for proton energy losses of over 80% due to particles being stopped completely. By direct integration of simplified propagation equations, distribution calculations are continued up to particle losses of 50%. (auth)

1614 ELECTROPRODUCTION OF PIONS AND THE ELECTROMAGNETIC FORM FACTOR OF PI MESONS. Lambrakos, Konstantinos Filoktiti. Austin, Tex., Univ. of Texas, 1968. 112p.

The possibility of measuring the electromagnetic form factor of the pi-meson by comparing properly the cross section for electroproduction of positive mesons with the cross section for electroproduction of neutral mesons has been investigated. A computer program (ATHENA) was written for the cross section of pion electroproduction and, in addition, a theoretical analysis of the first order Born approximation for the same process was carried out. It becomes apparent from the results of this investigation that an accurate measurement of the pion form factor for momentum transfer higher than $3F^{-2}$ is feasible. (Disser. Abstr:)

1615 SUM RULES FOR PROTON COMPTON SCATTERING. Costa, G. (Univ., Padua); Savoy, C. A.; Shaw, G. Nuovo Cim., 57A: 890-3(Oct. 21, 1968).

Data from a previous bubble chamber experiment on proton Compton scattering (Phys. Rev., 155: 1477(1967)) are evaluated for photon energies $1.5 < \nu < 2.5$ GeV using finite-energy sum rules. The sum-rule approach allows information to be obtained on the Regge terms from low-energy data. Total cross section predictions for the two cases — pure P′ and vector dominance coupling — are plotted against available data. (L.B.S.)

1616 DISPERSIONAL SUMMING RULES FOR THE PROCESS OF PHOTOGENERATION OF PIONS FROM NUCLEONS AT THE FIXED u. Radutskii, G. M. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 142-3(1968). (In Russian).

Previous works with sum rules resulting from dispersion relations and the assumption of fast reduction of amplitudes at high energies produced results which did not follow the high-spin-unitary symmetries. The sum rules were written for pion photoproduction amplitudes at fixed μ coefficients of vector meson interactions with nucleons obtained by approximate saturation of the sum rules by the contributions N(938), N*(1518), Δ(1236), ρ(760), and ω(783) to the corresponding channels of the reaction. The written out sum rules produced coefficients for vector meson interactions with nucleons ($g_{2\omega}NN/g_{1\omega}NN = 0.34$ and $g_{2\rho}NN/g_{1\rho}NN = 1.41$). The above relations were also obtained from studies of pion photoproduction by nucleons, electromagnetic nucleon structure and NN scattering. (R.V.J.)

Weak

Refer also to abstract 1585.

1617 LOW ENERGY LIMITS OF A K_{l_4} FORM FACTOR. Griffith, R. W.; Renner, B. (California Inst. of Tech., Pasadena). Contract AT(11-1)-86. Phys. Lett., 27B: 650-2(Oct. 14, 1968).

In response to a recent letter, it is shown that the soft pion theorems on K_{l_4} decays are consistent with the Callan-Treiman relation on K_{l_3} decays and do not require $\xi = 1$. (auth)

1618 THE DECAY $K^0_2 - \pi^+\pi^-e^+e^-$ AND THE RADIUS OF $K^0_2 - K^0_1$ ELECTROMAGNETIC TRANSITION. Kondratyuk, L. A.; Ponomarev, L. A.; Zakharov, V. I. (Inst. for Theoretical and Experimental Physics, Moscow). Phys. Lett., 27B: 655-6 (Oct. 14, 1968).

It is shown that in lowest order in the momentum of virtual photon the matrix element of the decay $K^0_2 - \pi^+\pi^-e^+e^-$ is expressed through the matrix element of the decay $K^0_2 - \pi^+\pi^-\gamma$ and the radius of $K^0_2 - K^0_1$ electromagnetic transition. (auth)

1619 CONSERVATION OF TWO KINDS OF NEUTRINOS AND FERMIONS. Wang, Ming-hsuan. Hsueh Shu Yen Chiu Tzu Jan K'o Hsueh Pan, No. 2, 1-5(Feb. 1963). (In Chinese).

It is generally believed that the number of light particles is constant, but as far as it is currently known, there is not yet a concrete theory to eliminate those reactions that are experimentally impossible. In the course of studying W particles, the existence of two kinds of neutrinos was discovered: one accompanying e and the other accompanying μ. On this basis, the theory of utilizing e^-, μ^-, Ve, and V_μ as the positive particles to re-examine and revise the reactions relating to the conservation of light particles is proposed. With this theory, the experimentally impossible reactions may be entirely eliminated and thus the conservation of light particles may be affirmed. This theory is used to produce some reactions that could possibly be discovered. Many scientists have worked to verify theoretically and experimentally the conservation

of fermions. Currently, it seems that the conservation of heavy particles is beyond doubt. In fermions, aside from the heavy particles, there are only the light particles; therefore, for the purpose of resolving the problem of conservation of fermions, it is in fact only necessary to verify the conservation of light particles. If the reaction process can satisfy the classical conservation of energy, momentum, angular momentum, and electrical charge, many reaction processes may be formulated. Reactions relating to this theory are demonstrated. (auth)

1620 SOME RESULTS OF THE ALGEBRA OF CURRENTS IN WEAK INTERACTIONS. PART I. THE DECAYS $K \to 2\pi$ AND $K \to 2\pi\gamma$. PART II. RELATION BETWEEN VECTOR AND AXIAL-VECTOR CABIBBO ANGLES IN BROKEN SU(3) SYMMETRY. Nasrallah, Nasrallah Fares. Chicago, Univ. of Illinois. 53p.

Thesis.

The decays $K^+ \to \pi^+\pi^0$ and $K_1^0 \to 2\pi$ are studied using the algebra of currents. It is shown that the decay $K^+ \to \pi^+\pi^0$ is not due to the violation of the selection rule $\Delta I = 1/2$ caused by the electromagnetic mass difference $m_{K^+}^2 - m_{K^0}^2$, as has been conjectured by some authors but has to be accounted for by the $I = 3/2$ part of the weak Hamiltonian. A search is also made for effects of CP violation in differences of the decay rates $\Gamma(K^+ \to \pi^+\pi^0) - \Gamma(K^- \to \pi^-\pi^0)$ and $\Gamma(K^+ \to \pi^+\pi^0\gamma) - \Gamma(K^- \to \pi^-\pi^0\gamma)$ in the theory of Nishijima and Swank; no evidence for these differences being different from zero. The renormalization of the weak axial-vector coupling constant in the decay $\Xi^0 \to \Sigma^+ e^- \bar{\nu}$ is calculated on the basis of the assumption that the symmetry breaking is unimportant at high energies. The result is used to show that the equality between vector and axial-vector Cabibbo angles, which is expected to hold in the limit of exact SU(3) symmetry, is preserved by the symmetry breaking. (Disser. Abstr.)

1621 PHENOMENOLOGICAL THEORY OF K^0 MESONS AND THE NON-EXPONENTIAL CHARACTER OF THE DECAY. Khalfin, L. A. (Steklov Mathematics Inst., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 8: 65-8(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 106-9(July 20, 1968).

In the phenomenological K^0-meson theory, it has been shown that unitarity relations and their consequences are very sensitive to the assumption that the decay of K_L or K_S is strictly exponential. It is thus shown that if the mass distributions of the K_L and K_S have poles of higher order than the first, then it follows automatically from the unitarity relation that $\langle K_L(0)|K_S(0)\rangle = 0$ regardless of whether CP-invariance is conserved or not. (L.B.S.)

1622 WEAK INTERACTIONS IN ^{3}He. Peterson, Earl Andrew. Stanford Calif., Stanford Univ., 1968. 136p.

One of the most interesting unsettled questions in nuclear weak-interaction theory concerns the magnitude of the induced pseudoscalar coupling constant, F_P. The theoretical prediction, $F_P \sim 8\ F_A \doteq -9.5$, is inconsistent with values derived from recent calculations of radiative muon capture which result in $F_P = (14 \pm 4)\ F_A$. A calculation of ordinary muon capture in ^{3}He is presented, utilizing the large amount of available information concerning this nucleus to minimize the uncertainties due to the nuclear wave function. An effective Hamiltonian correct through terms of order $(1/\text{nucleon mass})^2$ is employed, and the relativistic terms are treated exactly. Recent work determining the electromagnetic form factors of the ^{3}H–^{3}He doublet is used to fix the rather complicated nuclear wave function. The exchange effects are also fully discussed and a phenomenological model is used to calculate their contribution to the capture rate. The basis for the model is a comparison of experimental and theoretical information of the beta decay of ^{3}H, and supporting information is derived from a treatment of the static magnetic moments of ^{3}H and ^{3}He. When the results of this calculation are compared with the experimental capture rates, two conclusions can be drawn. First, that no agreement between theory and experiment is possible if the exchange effects are neglected, and second, that if the proposed model for the exchange effects is adopted, the induced pseudoscalar coupling in ^{3}He is in the range $6 \leq F_P/F_A \leq 32$. Part II is concerned with the elementary particle theory of the weak interactions of the ^{3}H–^{3}He system, in which the nuclear matrix elements are expressed in terms of phenomenological form factors instead of integrals with nuclear wave functions. The conserved vector current and partially conserved axial current theories are used to acquire as much information about the form factors as possible, but this is shown to be insufficient to completely determine the muon capture process. To explore the possibility of gaining more information about the form factors a sum rule for the axial vector form factor (at zero momentum transfer) is derived and evaluated. The sum rule is analogous to the (highly successful) Adler–Weisberger sum rule for the axial vector coupling constant of the nucleon, but contains additional terms due to the fact that ^{3}H can break up into neutron-deuteron or neutron-neutron-proton systems. These additional contributions dominate the sum rule and result in the prediction that the square of the ^{3}He form factor is negative, an unacceptable conclusion. An examination of the underlying assumptions suggests that the partially conserved axial current theory should be modified. (Disser. Abstr.)

1623 APPLICATION OF CURRENT ALGEBRA TO OCTET DOMINANCE IN HYPERON NON-LEPTONIC DECAY AND TO SU(3)-SYMMETRY BREAKING. Simmons, Walter Andrew. Lafayette, Ind., Purdue Univ., 1968. 85p.

Thesis.

Recent work on the nonleptonic decays of the hyperons in which the current algebra and the current-current form of the weak interaction have been used is reviewed and extended. It is noted that the weak current-current Hamiltonian could be taken to transform under SU(3) as an octet plus an arbitrary admixture of twenty-seven-plet were it not for the observed smallness of the parity violating amplitude for the decay $\Sigma^+ \to n\pi^+$ which is known to be engendered only by the twenty-seven-plet. Using the techniques of current algebra and PCAC the weak, parity-violating decay amplitudes are expressed in terms of matrix elements of the weak hadron currents between single baryon states. These matrix elements can then be written in terms of form factors corresponding to the vector and axial vector currents. The nucleon electromagnetic form factors are known from experiment but the other form factors needed to evaluate the amplitudes are not. The form factors are related as follows. The form factors for the vector current between single octet baryon states are related to the nucleon electromagnetic form factors through the CVC hypothesis. The axial vector form factors present the most formidible problem since little is known about them. A study of several models for these form factors suggests that the f/d ratio of the axial vector current is independent of the momentum transfer, is the same for the axial and the induced pseudoscalar form factors, and is equal to approximately $^2/_3$ (in agreement with experiments on semi-leptonic decays). Taking this as an assumption it is found that the expression for the nonleptonic decays can be cast into a form in which the origin of the suppression of the twenty-seven-plet becomes apparent. It is concluded that subject to the assumption about f/d the suppression of the twenty-seven-plet is an inherent property of the current-current form of the weak interaction. Using more restrictive assumptions about the nature of the axial vector form factors based upon models, numerical values for the nonleptonic amplitudes are obtained. It is shown that these numbers are model-dependent but that for at least one model the values are in agreement with experiment to the extent that would be expected on the basis of the restrictiveness of the model. The techniques developed in the study of the nonleptonic hyperon decay are then applied to the question of SU(3) symmetry breaking. It is hypothesized that the SU(3) breaking interaction is of a current-current form. Several models of this type are examined to give information about meson-baryon coupling constants. The results are compared to those of other models. (Disser. Abstr.)

1624 WEAK, STRONG, AND ELECTROMAGNETIC INTERACTIONS OF INTERMEDIATE VECTOR MESONS. Okubo, S. (Univ. of Rochester, N. Y.). Nuovo Cim., 57A: 794-802(Oct. 21, 1968).

A nonet of Yang–Mill intermediate vector mesons was introduced with weak interaction having the maximum CP violation. A unitary-singlet part of this nonet is assumed to have a strong Yukawa-type interaction with hadronic currents. It may be identified with Ne'eman's fifth interaction, which may also account for the large-angle high-energy p-p scattering. Finally, a neutral member of the vector meson is taken to be a source of electromagnetic interactions of charged leptons in order to account for the anomalous muonic g–2 value. (auth)

Strong (General)

Refer also to abstract 1624.

1625 (SLAC-PUB-508) RESONANCES (THEORY). Harari, Haim (Weizmann Inst. of Science, Rehovoth (Israel). Stanford Linear Accelerator Center, Calif.). Sept. 1968. 77p. (CONF-680809-32). Dep. CFSTI.

From 14th International Conference on High Energy Physics, Vienna, Austria.

Two main theoretical topics related to the interpretation of resonant states are discussed. These are the present status of various hadron classification schemes and the role played by resonance states in the present understanding of strong interaction dynamics. The topics discussed include various theoretical models for meson spectroscopy including the quark model Regge theory, SU(3), and chiral SU(2) × SU(2). The baryon spec-

trum is treated with an emphasis on SU(3) and the quark model. The general question of the relation between t-channel Regge trajectories and s-channel resonances is considered. Possible mechanisms which may lead to loops in the Argand diagram for partial wave amplitudes are discussed. The speculative picture according to which most of the observed hadron reactions may be described in terms of sums of resonance excitations is also discussed. (C.E.S.)

1626 REDERIVATION OF SU(6) MASS FORMULAS FROM THE EXTENDED CURRENT COMMUTATION RELATION. Nakamura, Morio (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 432-4(1968).

The SU(6) mass formulas between pseudoscalar mesons and vector mesons and also between octet baryons and decimet resonances are obtained from extented current commutation relations. (L.B.S.)

1627 CROSSING AND UNITARITY IN A MULTICHANNEL STATIC MODEL. I. Ehrhardt, P. O. G.; Fairlie, D. B. (Univ. of Durham, Eng.). J. Math. Phys. (N. Y.), 9: 1685-9(Oct. 1968).

The infinite multichannel-scattering process of the two-particle scattering of mesons of arbitrary isospin off an isospin-$\frac{1}{2}$ target, inelastic two-particle channels being admitted, is considered in the static limit. The restrictions on the S matrix arising from crossing under SU(2) and two-particle unitarity are expressed in terms of three equations alone in the limit of degenerate meson masses. These equations are solved by a perturbative technique, the expansion parameter being a measure of the strength of the inelastic scattering. The principal result is that the inelastic amplitudes are all related, so that if one is zero all must be zero. Comparisons are made with strong-coupling theory, which also requires an infinite number of channels. (auth)

1628 EXISTENCE OF QUARKS. Azuma, Shigeru (Osaka Municipal Univ.). Kagaku (Tokyo), 38: 132-6(Mar. 1968). (In Japanese).

The answer for the question, what occurs when matter is divided infinitely, changes continuously as the energy available for mankind is raised. At the present, the quark model is proposed as one possibility. Concerning this quark, its possible sites of detection, the detection methods, as well as its properties are first described. Then, the facility for observation of the quark, installed at the Osaka City University, and the observation with it and the data analysis, are described in detail. The facility, in general, consists of six plastic scintillators and four wire chambers. In Osaka City Univ., no quark has been detected by 2100-hr land observation. (NSA of Japan)

1629 EMPIRICAL MASS REGULARITIES OF RESONANCE STATES. Shirkov, D. V. (Inst. of Mathematics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR, 181: 837-9(Aug. 1, 1968). (In Russian).

In dispersion analysis it is convenient to use the scale: $x = s - m_i^2 - M_i^2$. Here m_i is the mass of the incident particle and M_i is the target mass. It is shown that this variable gives a simple classification of two-particle resonances. The value of the parameter x is calculated for 8 resonance states decaying to two mesons by the formula: $x_i = M_{ik}^2 - m_i^2 - M_k^2$. Here M_{ik} is the mass of the resonance decaying to the particles m_i and M_k. The value of x for the $\pi + \pi$, $\pi + K$ and $K + \bar{K}$ resonances varied only slightly, and was found to be 0.55 for the $P(1^-)$ level, 1.70 for the $D(2^+)$ level, and 2.80 for the $F(3^-)$ level. An analysis of 18 meson-baryon resonances and 3 bound states shows that the value of x is relatively constant for M + B-resonances. Thus it becomes possible to express the horizontal distances between Regge trajectories by the difference in squares of the masses of the products of the main mode of decay. It is possible to obtain mass formulas relating the resonance masses within multiplets to the squares of the masses of stable particles. These formulas are squared with respect to the masses both for M + M− and also for M + B− resonances. The potential of the interaction practically does not depend on the type of interacting particles. (TTT)

1630 INTERPRETATION OF THE TRANSVERSE-MOMENTUM DISTRIBUTION OF PARTICLES IN HIGH-ENERGY HADRON COLLISIONS. Cocconi, G. (CERN, Geneva). Nuovo Cim., 57A: 837-48(Oct. 21, 1968).

The characteristic Gaussian angular distribution of the two-body reactions produced by high-energy hadrons is correlated to the overall exponential distribution of the particles produced in the multibody processes. These properties, common to both the elastic and inelastic interactions, are then interpreted as the manifestation of the multiple scattering of subunits (possibly quarks) present in all hadrons. (auth)

1631 INCONSISTENCY OF A MODIFICATION OF THE ADLER–FUBINI SUM RULE. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 21: 1465-7(Nov. 11, 1968).

It is shown that the local current algebra of charge densities is inconsistent with a recent proposal for modifying the Adler–Fubini sum rule. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 1653 and 1611.

1632 (CEA-R-3479) CONTRIBUTION TO THE PHENOMENOLOGICAL STUDY OF TWO-BODY REACTIONS AT HIGH ENERGY. Cohen-Tannoudji, Gilles (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 122p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

A phenomenological model suited for the description of arbitrary two-body reactions at high energies is presented and applied to the analysis of πN, KN, and $\bar{K}$N scattering. The idea is that the Regge-pole model does not take into account the whole content of the unitarity relation and has to be modified, as is currently done in one-particle exchange models, so that it may include absorptive corrections. In terms of a rather economical set of free parameters, a satisfactory agreement with all available data is obtained, including the recent evidence for a nonvanishing polarization in $\pi^- p \to \pi^0 n$ reaction. The parametrization of the amplitudes is reinterpreted in terms of poles and branch points in the complex angular-momentum plane for the crossed channel. (auth)

1633 (IS–1948) RESONANT PARTICLE MASS STRUCTURE DUE TO A SECOND ORDER POLE. Ruuskanen, P. V.; Lassila, K. E. (Iowa State Univ. of Science and Technology, Ames). Oct. 14, 1968. 13p. Dep. CFSTI.

Combined data from previous measurements showing a double-peak structure for the A_2 are found to be well fitted by a double-pole resonance formula $N(E) \alpha (E - E_0^2)/[(E - E_0)^2 + \Gamma^2/4]^2$. A general formula for the cross section is presented from which the double-pole resonance follows as a special case. Other implications of the proposed model are discussed. (L.B.S.)

1634 MESONS OF ABNORMAL CHARGE PARITY. Galfi, L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 24: 381-90(1968).

The strong and electromagnetic decays of mesons of abnormal charge parity of spin 0 and 1 are examined. The allowed decays are determined, and an attempt is made to find the simplest vertex for the given transition. The effective Hamiltonian, equivalent with the vertex, is composed from the field functions of the particles participating in the transition and from the derivatives of fields. The production of the abnormal mesons and the possibility of their observation are briefly discussed. (L.B.S.)

1635 LORENTZ-FACTOR AS A TOOL TO IDENTIFY RESONANCES. Khvastunov, M. S.; Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 27B: 653-4(Oct. 14, 1968).

It is pointed out that in some cases it is better to identify the light-particle-resonances produced in two-particle reactions by their Lorentz-factor rather than by their effective mass. (auth)

1636 SUPERCONVERGENCE RELATIONS FOR INELASTIC MESON–MESON SCATTERING. Schonberg, E. (Univ. of Chicago). Nuovo Cim., 57A: 777-84(Oct. 21, 1968).

Saturating superconvergence relations for $\pi\rho \to \pi f$, $\pi f \to \pi f$, $\pi\pi \to \pi A_2$ and $\pi\omega \to \pi A_2$ with $q\bar{q}$ s- and p-wave bound states, the ratio of s-wave to d-wave coupling for the $A_1 \to \rho\pi$ and $B \to \omega\pi$ decays, the partial widths $\Gamma(A_1 \to \rho\pi)$, $\Gamma(f \to A_1\pi)$ and the mass formula $m_{A_2} = m_\rho\sqrt{3}$ are obtained. (auth)

1637 STRONG ABSORPTION AND NEARBY-SINGULARITY APPROXIMATION. Cantore, A.; Marchesini, G.; Scotti, A. (Univ., Milan). Nuovo Cim., 57A: 886-9(Oct. 21, 1968).

A simple model of the $N\bar{N}$ interaction is considered in order to determine whether or not the strong short-range absorption, characteristic of this system can play the role of repulsion in the $N\bar{N}$ system. The nucleon is considered as a scalar particle and the absorption is simulated via the coupling of two scalar mesons. The partial-wave scattering amplitudes are obtained by solving a two-channel Bethe–Salpeter equation. The solutions are compared with those obtained by solving numerically the set of inelastic N/D equations for the $N\bar{N}$ system. The results imply that the presence of absorption does not act as a screen to the far-away singularities. (L.B.S.)

1638 TWO METHODS FOR INCLUDING INELASTICITY IN THE CALCULATION OF THE P-WAVE PION–PION AMPLITUDE. Hale, Barbara Nelson. Lafayette, Ind., Purdue Univ., 1968. 128p.

Thesis.

Two methods for including the effects of inelasticity on the p-wave pion-pion scattering amplitude are investigated. The first method involves the use of the phase representation in a modified single-channel N/D calculation. High energy inelasticity is estimated through the average total phase of the partial-wave amplitude for energies, E, greater than E_i. With a Reggeized rho-exchange input force using experimental values for the rho mass and width the results indicate that the assumption of an average total phase of $\pi/2$ for total center of mass energies greater than about 8 M_π does not produce any appreciable reduction in the width of the output p-wave pion-pion resonance. Also investigated are the effects of low energy inelastic channels which may contribute through the η (inelasticity) parameter for $E \leq E_i$. None of the choices for η ($E \leq E_i$) resulted in a width comparable to the experimental value. The second method is based on a multichannel, separable potential formalism; the two-channel ($\pi\pi$,$\pi\omega$) problem is considered. A narrow width (150 MeV) for the output resonance at 760 MeV in the $\pi\pi \rightarrow \pi\pi$ channel is shown to be possible using a simple Regge-type damping on the rho-exchange potentials; a comparable straight-cutoff approach (using the usual rho-exchange amplitudes) does not yield widths less than about 300 MeV. (Diss. Abstr.)

Strong (Baryon No. = 1)

Refer also to abstracts 1602, 1606, 1663, and 1704.

1639 (BNL–12811) ASYMPTOTIC ENERGIES. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Aug. 1968. 49p. (CONF-680629–1). Dep. CFSTI.

From International Symposium on Contemporary Physics, Trieste, Italy.

The experimental determination of forward scattering amplitudes at high energies and dispersion relation calculations are first discussed. The question of sensitivity of the calculations to asymptotic behavior of the total cross sections, and the demonstration of the validity of pion-nucleon forward dispersion relations reasonably independent of this behavior, are considered. The relations are then used to predict the asymptotic behavior of forward scattering amplitudes. (L.B.S.)

1640 (COO–264–445) MODEL FOR LOW ENERGY MESON–BARYON SCATTERING. Goldstein, Gary R. (Chicago Univ., Ill.). Aug. 1968. Contract AT(11-1)-264. 104p. (EFI–68–63). Dep. CFSTI.

An effective Lagrangian, containing relativistic SU(6) invariant three and four-point interaction terms, is constructed for the scattering of the 35 meson representation by the 56 baryons. The lowest order matrix elements calculated from the Lagrangian include single particle exchange terms, that account for long range forces, and four-point interaction terms, that approximate short range forces for low energy scattering. Due to the imposition of free field conditions on the scattered particles, the amplitudes maintain a coplanar U(3) ⊗ U(3) symmetry, which is then broken by the mass differences in the multiplets. There are three parameters in the model that are fixed by the S_{11}, S_{31}, and P_{11} scattering lengths for πN elastic scattering. Unitarity is implemented without introducing more parameters, by equating the matrix elements to the reaction matrix, K. The amplitudes for all other reactions contained in 35 ⊗ 56 scattering are determined thereby. In particular, the cross sections and angular distributions for $\pi N \rightarrow \pi N$, $KN \rightarrow KN$, $\pi N \rightarrow \eta N$, $\pi N \rightarrow K\Lambda$, $\pi N \rightarrow K\Sigma$ and $\bar{K}N \rightarrow \eta\Lambda$ are calculated near their thresholds and compared with experiment. In all cases where comparisons can be made the model is in fairly good agreement with the data, with the exception of $\pi N \rightarrow K\Sigma$. The threshold amplitudes for vector meson production are also given as a prediction of the model. (auth)

1641 GENERATION OF STRANGE PARTICLES IN πN COLLISIONS AT HIGH ENERGY. Ter-Ovanesov, E. F. (Leningrad Pedagogical Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 117–18(1968). (In Russian).

In inelastic processes the conservation laws (of isotopic spin, p and G parities, and charge) impose certain limitations on the number of possible amplitude poles in a complex momentum plane. The formation of strange particles in reactions (1) $\pi^- + p \rightarrow \Lambda + K^0$, and (2) $\pi^- + p \rightarrow \Sigma^0 + K^0$ were studied considering that in the (annihilation) t-channel the exchange with quantum numbers $T, J^P = \frac{1}{2}\ 1^-$ and the strangeness 1 are permissible. Calculations were made using K^+ meson with an inclined p-pole trajectory in the momentum transfer region $|t| < 1\ (GeV/c)^2 : \alpha(t) = 0.4 + 0.7\,t$. The Regge amplitude processes of the (1) and (2) reactions were set up according to universal rules. Moreover, the residue functions from t were not considered, i.e., they were expressed by coupling constant in the diagram vertex. The examined model is suitable for various processes of combined strange particle and π-meson generation and photoproduction reactions. (R.V.J.)

1642 SIMPLE MODELS FOR FORWARD-SCATTERING AMPLITUDES OF STRONGLY INTERACTING PARTICLES. Scheck, F. (CERN, Geneva). Nuovo Cim., 57A: 721–45 (Oct. 21, 1968).

Some well-known relations between forward-scattering amplitudes of mesons and baryons, originally derived from a quark model and the additivity assumption, are discussed in the framework of a Regge-pole model with universal coupling of the trajectories. For the vector contributions the two models are completely equivalent and experimentally indistinguishable. Concerning the tensor trajectories, their conjectured relation to the energy-momentum tensor is investigated. It is found that if there is any such relation, the tensor residues at t = 0 should be connected with definite pieces of the general (linear) SU_6 decomposition of meson and baryon masses. (auth)

1643 REGGEIZATION OF SOME UNEQUAL MASS PROCESSES INVOLVING HIGHER SPINS: THE REACTIONS $\pi N \rightarrow VN$, $\pi N \rightarrow V\Delta$, AND $\gamma p \rightarrow \pi^+ n$. Jones, Lorella Margaret. Pasadena, Calif., California Inst. of Tech., 1968. 99p.

Thesis.

Recent theoretical developments in the reggeization of inelastic processes involving particles with high spin are incorporated into a model of vector meson production. A number of features of experimental differential cross sections and density matrices are interpreted in terms of this model. The method chosen for reggeization of helicity amplitudes first separates kinematic zeros and singularities from the parity-conserving amplitudes and then applies results of Freedman and Wang on daughter trajectories to the remaining factors. Kinematic constraints on helicity amplitudes at t = 0 and $t = (M - M_\Delta)^2$ are also considered. It is found that data for reactions of types $\pi N \rightarrow VN$ and $\pi N \rightarrow V\Delta$ are consistent with a model of this type in which all kinematic constraints at t = 0 are satisfied by evasion (vanishing of residue functions). As a quantitative test of the parametrization, experimental differential cross sections of vector meson production reactions dominated by pion trajectory exchange are compared with the theory. It is found that reduced residue functions are approximately constant, once the kinematic behavior near $t = (M - M_\Delta)^2$ has been removed. The alternative possibility of conspiracy between amplitudes is also discussed; and it is shown that unless conspiracy is present, some amplitudes allowed by angular momentum conservation will not contribute with full strength in the forward direction. An example, $\gamma p \rightarrow \pi^+ n$ in which the data for $d\sigma/dt$ indicate conspiracy, is studied in detail. (Disser. Abstr.)

1644 REGGE QUARK-MODEL DESCRIPTION OF THE πp CHARGE-EXCHANGE, $\pi p \rightarrow \eta n$ AND Kp CHARGE-EXCHANGE REACTIONS. Logan, R. K. (Univ. of Toronto). Nuovo Cim., 57A: 712–20(Oct. 21, 1968).

The Regge quark-model is used to describe the differential cross sections of the πp charge-exchange, $\pi p \rightarrow \eta n$ and Kp charge-exchange reactions. The choice of the scaling factor $s_0 = 2m_A m_B$ is shown to yield constant residues and give agreement between experiment and theory within 25%. (auth)

1645 TWO-MESON EXCHANGE CONTRIBUTION FOR $K^- + p \rightarrow \Sigma^+ + \pi^-$. Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Nuovo Cim., 57A: 875–8(Oct. 21, 1968).

It is shown that the anomalous behavior of the backward and forward peaking in the angular distribution curves for the $K^- + p \rightarrow \Sigma^+ + \pi^-$ interaction can be explained reasonably well by considering contributions from a two-particle exchange diagram in addition to the one-particle $\bar{K}^*$-exchange diagram. (L.B.S.)

1646 DISPERSION THEORY AND MULTICHANNEL POTENTIAL MODEL OF π–N SCATTERING IN THE $I = J = \frac{1}{2}^+$ STATE. Sheth, Bidhanchandra Ishwerlal. Lafayette, Ind., Purdue Univ., 1968. 113p.

Thesis.

Recent calculations of Doolen, Kanki and Tubis, using a single channel N/D formalism with a variant of Balázs method, have given results which are consistent with the picture of nucleon as a composite particle state whose approximate mass and coupling with pions are deducible from standard assumptions concerning charge independence, crossing symmetry, analyticity and unitarity. However, their calculated πN, $I = J = \frac{1}{2}^+$ state phase-shift is in strong contradiction with experiment. We modify the formalism of Doolen et al., to include effects of inelasticity using the modified phase representation and the R method with the phase representation. The calculated nucleon parameters $g^2/4\pi$ and m are

roughly the same as those found by Doolen et al., but the calculated phase-shift still differs considerably from the experimental one. We then assume that the observed phase-shift behavior is due to multichannel coupling and adjust the parameters of a Castillejo-Dalitz-Dyson (CDD) pole to obtain agreement with the observed phase-shift in the 100-600 MeV range laboratory kinetic energy. The calculated nucleon parameters are $g^2/4\pi = 10.5$ and $m = 0.97$ (in the units of the physical nucleon mass). The effects of including inelasticity in this formalism are also examined. A simple, two-channel calculation, based on a separable potential model, is then performed. The parameters of the model are adjusted so as to produce a nucleon bound state at the physical nucleon mass, a zero in the T_{11} amplitude at a pion lab kinetic energy of 150 MeV, and the Roper Resonance at a pion lab energy of 600 MeV. We obtain a fairly good agreement with the observed phase-shift and the inelasticity parameter and find $g^2/4\pi = 15.2$ and the πN, $I = J = \frac{1}{2}^+$ scattering length, a_{11}, to be -0.06 (in units of the cube of the pion Compton wavelength) in fair agreement with the experimental values of $g^2/4\pi = 15.1 \pm 0.6$ and $a_{11} = -0.101 \pm 0.007$. Thus our models show that the picture of the nucleon as a composite particle state has a qualitative validity. (Diss. Abstr.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 1642, 1704, and 1810.

1647 (JINR-D1-4001) POSSIBLE EXPLANATION OF THE CROSS SECTIONS OF THE p−p ELASTIC SCATTERING AT HIGH ENERGIES IN THE ANGLE INTERVAL FROM $0 < \Theta < 90°$. Tolstov, K. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1968. 14p. Dep.

The differential cross sections of the p-p elastic scattering measured at high energies and in the angle between 0 and 90 degrees are described on the basis of two discrete values of a transverse momentum. (W.H.K.)

1648 (JINR-P2-4065) SCHEME OF CALCULATION OF INTRANUCLEAR CASCADES. Barashenkov, V. S.; Gudima, K. K.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 17p. (In Russian). Dep.

The program is described of the calculation of the cascade interactions of particles with atomic nuclei in the energy region from several tens of MeV up to $T \simeq 30$ GeV. The diffuseness of the nucleus boundary is taken into account; while calculating, the laws of the energy and momentum conservation are observed. (auth)

1649 SCATTERING OF PROTONS BY DEUTERIUM AND HELIUM. Franco, Victor (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 21: 1360-4(Oct. 28, 1968).

Results are presented of detailed spin- and isospin-dependent analyses of pd and p-^{4}He elastic scattering intensities, polarizations, and total cross sections. The basic nucleon-nucleon scattering amplitudes used yield nucleon-nucleon observables in excellent agreement with measurements, including those of the elastic-scattering intensity, polarization, and spin correlation. Contributions of multiple scatterings, including multiple charge-exchange collisions, produce considerable structure in the predicted polarizations. (auth)

1650 NUCLEON–NUCLEON SCATTERING THROUGH APPLICATION OF THE PADE APPROXIMANT. Wortman, William Robert. College Station, Tex., Texas A and M Univ., 1968. 124p.

In an effort to improve upon the predictions of pseudoscalar meson theory, the method of Pade approximants is applied to nucleon-nucleon scattering. All diagrams contributing to the S-matrix through fourth order in the coupling constant are computed by expressing the amplitudes in dispersion relation form by means of Cutkosky's rules. In addition to pion and nucleon intermediate states, other particles occurring in the same representations of SU(3) as the pion and nucleon respectively are considered subject to both exact SU(3) symmetry and broken mass SU(3) symmetry. The resulting truncated S-matrix is then replaced by a modified S-matrix found by the [1,1] Pade prescription. Phase shifts are computed from the exactly unitary modified S-matrix. The results indicate that for the high angular momenta phase shifts, the Pade method offers no particular improvement over the perturbation method. However, there is evidence that for the intermediate angular momenta phase shifts, the enforcement of unitarity leads to improved predictions, but for some of these phase shifts, the results are completely unreasonable. In the low angular momenta region, a bound $^3S_1$ state is found although its character is rather unlike that of the deuteron. The $^1S_0$ state shows no evidence of being almost bound as it is physically known to be. It is found that differences between several one-pion-exchange phase shifts and the experimental phase shifts can be attributed largely to two-pion-exchange effects. The addition of particles other than pions and nucleons in intermediate states subject to SU(3) symmetry seems to have relatively little effect on the results, especially in the case of broken mass SU(3) symmetry. (Disser. Abstr.)

1651 REGGE BEHAVIOUR, KINEMATICAL SINGULARITIES, AND FIXED POLES. Caser, S.; Basdevant, J. L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 57A: 785-93(Oct. 21, 1968).

It is shown that the problems of daughter trajectories, conspiracy, and evasion, are closely related to the existence of fixed poles in angular momentum. If one has some reason to discard fixed poles, then daughters, conspirators or vanishing residues, occur. This is obtained by assuming the scattering amplitude below threshold to be given by a dispersion integral on the Regge behavior above threshold. (auth)

1652 DIFFRACTION SCATTERING OF COMPOSITE PARTICLES. Pumplin, Jonathan Conrad. Ann Arbor, Mich., Univ. of Michigan, 1968. 86p.

Thesis.

Various models were used to study the scattering of a high energy particle from a bound system of several particles, calculating the scattering from the system in terms of the amplitudes for quasi-free scattering from its constituents. These amplitudes are taken to correspond to elastic diffraction scattering, which is the dominant process at many-BeV energies. Applications are made to scattering of elementary particles from deuterium and other light nuclei; to deuteron-deuteron scattering, and to multiple scattering in quark models. (auth) (Disser. Abstr.)

1653 HYBRID MODEL FOR ELASTIC SCATTERING. Chiu, C. B.; Finkelstein, J. (CERN, Geneva). Nuovo Cim., 57A: 649-64(Oct. 21, 1968).

A model is presented for the large-energy, small-angle scattering of hadrons, which is a combination of the optical and the Regge models. In the infinite-energy limit, the model reduces to the one suggested by Chou and Yang, but at finite energies there are corrections arising from the exchange of Regge poles (excluding the Pomeranchukon) and cuts. With a very simple form of this model — only one Regge trajectory is included, parametrized as simply as possible — an attempt is made to understand pp scattering. It is found that the structure observed in the pp differential cross section is reproduced. The calculated cross section shows breaks at $-t \approx 1.2$ GeV^2 and 5.5 GeV^2, and has correct energy dependence. In further applications of this model, the cross-over in the $\bar{p}p$ and pp differential cross sections near the forward directions is reproduced, and a dip in the $\bar{p}p$ differential cross section near $-t \approx 0.7$ GeV^2 at high energy is predicted. (auth)

1654 THE FADDEEV EQUATIONS IN HELICITY EIGENSTATES WITH AN APPLICATION TO π-d SCATTERING. Doolen, Gary Dean. Lafayette, Ind., Purdue Univ., 1968. 124p.

Thesis.

The exact three-particle Schroedinger equation for the scattering of one particle from a bound state of the other two particles is written in terms of three-particle helicity states using the Faddeev form of the equations. These equations are convenient for including any two-body particle-wave amplitude and the effects of spin. These non-relativistic equations are applied to a separable potential model for π-d scattering in which the π-N amplitude is allowed to resonate in a p-wave similar to the N*(1238). The computer solution of the equations obtained indicates that multiple scattering effects are small but not negligible. A comparison is made of the exact single scattering amplitude and the impulse approximation amplitude. The upper bound for the number of binary collisions of point particles allowed by energy and momentum conservation is also obtained. The relationship of classical collisions to the rescattering singularities is also discussed. (Diss. Abstr.)

1655 LOW-ENERGY BARYON–BARYON INTERACTION. Dante, William Michael. Seattle, Univ. of Washington, 1968. 96p.

Thesis.

A model is proposed for the low energy baryon-baryon interaction which uses a potential in a Schroedinger equation to obtain phase shifts, scattering lengths, and effective ranges. The potential is obtained by summing the allowed one boson exchange potentials for the observed mesons. SU(6)W symmetry, broken by a spurion with the quantum numbers of the eta meson, is used to obtain the coupling constants. Deviations from exact symmetry are further taken into account by using the physical masses for both the exchanged mesons and the baryons. At short range the potential is replaced by a boundary condition that is assumed to be invariant under, at least, SU(3). The model is not particularly sensitive to the boundary radius which is chosen to be consistent with no binding in the singlet n-p system. The paucity of experimental data leaves us with only one comparison that can be made with experi-

ment. The agreement here is poor and it is suggested that the sensitivity of the model to the boundary condition makes the assumption of SU(3) symmetry invalid. A number of suggestions are made for improvement of the model. A 2.4 MeV bound state of the sigma cascade in the spin 0, isospin $\frac{3}{2}$, channel is a prediction of the model which may be worth some experimental investigation. No other spin singlet bound state is predicted among the interactions investigated. A number of predictions of scattering lengths and effective ranges are made and a comparison with other approaches is carried out. (Diss. Abstr.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 1608.

1656 (IC-68/86) IRREDUCIBILITY OF THE LADDER REPRESENTATIONS OF U(2,2) WHEN RESTRICTED TO ITS POINCARE SUBGROUP. Mack, G.; Todorov, I. (International Centre for Theoretical Physics, Trieste (Italy)). July 1968. 24p. Dep.

It is shown that the most degenerate discrete series of unitary irreducible representations of U(2,2), the so-called ladder representations, remain irreducible when restricted to representations of the Poincaré subgroup ISL(2,C). They correspond to representations of this subgroup with mass zero and arbitrary integer or half-integer spin j and helicity $\lambda = \pm j$. The basis vectors of the canonical basis are calculated as functions of a light-like 4-vector, which is formed by the simultaneous eigenvalues of the generators of the subgroup of translations. (auth)

1657 (ITF-68-2) HIGHER-VECTOR REPRESENTATIONS OF SEMISIMPLE LIE ALGEBRAS. Klimyk, A. U. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1967. 55p. (In Russian). Dep.

A relation is derived for weight multiplicities of any (not only finite dimensional) irreducible representation with an integer higher weight of a semisimple Lie algebra. This relation is used to derive a formula for characters of such representations. In the case of a finite dimensional representation the formulas obtained are identical with the Costant formula for weight multiplicities and the Weyl formula for characters respectively. The representations considered are of interest due to the fact that the closure of the spaces of these representations in a topology specially introduced brings us a part of representations of the discrete series of a real semisimple algebra. (auth)

1658 MULTIPLICITY PROBLEM FOR COMPACT SUBGROUPS OF NONCOMPACT GROUPS. Klink, William H. (Univ. of Iowa, Iowa City. Argonne National Lab., Ill.). J. Math. Phys. (N. Y.), 9: 1669-79(Oct. 1968).

A method is shown for calculating the multiplicities occurring in the reduction of a reducible representation of a compact group. The reducible representation is obtained by constructing induced irreducible representations of a noncompact group and then restricting the elements of this representation to elements of the compact subgroup. (auth)

1659 UNITARY IRREDUCIBLE REPRESENTATIONS OF SU(2,2). II. Yao, Tsu (Rutgers State Univ., New Brunswick, N. J.). J. Math. Phys. (N. Y.), 9: 1615-26(Oct. 1968).

Paper II of this series [Paper I in J. Math. Phys., 8: 1931 (1967)] is concerned with a general study of the degenerate representations. The explicit expressions for the "raising" and "lowering" functions $a_i^2(p,q,\lambda)$, and $b_i^2(p,q,\lambda)$, $i = 1, 2, 3, 4$ are found. The three Casimir operators C_2, C_3, and C_4 depend on only two complex parameters A and B, a fact reflecting the degenerate nature of the representations under study here. The finite representations are studied first, and thus provide a proof for the degenerate part of Theorem 2, Paper I. The unitary representations are studied next, and it is found that there are fourteen classes of degenerate unitary irreducible representations. There are two continuous series, ten discrete series, and two series which depend on one discrete and one continuous parameter. The degenerate part of the $D^{\pm}$ series is studied, and thus provides an explicit demonstration of Harish-Chandra's theorem. (auth)

1660 UNITARY REPRESENTATIONS OF THE GENERALIZED POINCARE GROUPS. Novozhilov, Yuri V. (Univ., Leningrad. Univ. of Delhi); Terentjev, Igor A. J. Math. Phys. (N. Y.), 9: 1517-26(Oct. 1968).

The problem of the explicit construction of unitary representations is solved for the generalized inhomogeneous Poincaré groups ISL(n,C) and their subgroups. As a key to the solution, a method is developed to find the generalized Wigner operator, which transforms a given n^2 momentum to the standard one. Results are also specified for the U(m,m) subgroup of the group ISL(2m,C). (auth)

1661 RELATIVISTIC INVARIANCE WITHOUT ANGULAR-MOMENTUM CONSERVATION. Selleri, F. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim., 57A: 678-88(Oct. 21, 1968).

It is shown that, contrary to a rather widespread belief, relativistic invariance does not necessarily lead to angular-momentum conservation. Noticing that there is no empirical evidence for such a conservation in weak interactions, it is shown that a new classification of strange particles is possible in which the K-meson has spin $\frac{1}{2}$, the Λ and Σ have spin 1 and the Ξ has spin $\frac{3}{2}$. The scheme can be proved or disproved with simple experiments. (auth)

1662 ON NECESSARY AND SUFFICIENT CONDITIONS FOR THE s = 2r REALIZATIONS OF DYNAMICAL SYMMETRIES AS FUNCTION GROUPS. Bunchaft, F. (Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cim., 57A: 689-98(Oct. 21, 1968).

A theorem is proved that gives necessary and sufficient conditions for the realization of dynamical symmetries as function groups for all not exceptional semi-simple Lie algebras, by the minimum number of independent functions. The theorem implies that no $s = 2r$ realizations exist of B_r ($r \geq 3$) and D_r ($r \geq 4$) and that $s = 2r$ realizations of A_r and C_r are always possible. The explicit realizations of A_r and C_r are given. It is verified that C_r ($r \geq 2$) has all Casimir functions identically zero. (auth)

1663 THE EMBEDDING OF SU(3) IN HIGHER SYMMETRIES AND APPLICATIONS TO ELEMENTARY PARTICLE PHYSICS. Carlstone, Darry Scott. Lafayette, Ind., Purdue Univ., 1968. 201p.

Thesis.

The higher symmetries of SU(6) and SU(8) are proposed as possible noninvariance groups of SU(3). The basic step in constructing these algebras is to embed the eight (six) dimensional representation of SU(3) in the eight (six) dimensional representation of SU(8) (SU(6)). The adjoint representation of each of these two symmetries will contain an octet which is identified with the generators of SU(3). Once this identification has been made, all representations of SU(6) and SU(8) may be classified in terms of their SU(3) context. Mass formulas for some of the more interesting representations are determined. These mass formulas are compared with the available experimental information in order to determine whether there is immediate evidence for such a scheme. It appears that there is not. The higher symmetry models are also applied to the nonleptonic decays. The results of the SU(3) baryon pole model are explained in terms of SU(8). Also, both SU(8) and SU(6) are applied to the current-current model. It is shown that if SU(8) can be interpreted so that all interactions belong to the sixty-three dimensional representation, the current-current model together with the experimental value for the D/F ratio for semileptonic decays can explain the apparent octet dominance for the nonleptonic decays of baryons. (Disser. Abstr.)

1664 GENERALIZATION OF THE TIME INVERSION OPERATOR IN THE FERMION MODEL. Lebedev, L. E. (Dnepropetrovsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 153-4(1968). (In Russian).

A generalization of time reversal operator in fermion model was obtained by expansion of general Lorentz group. (R.V.J.)

Applications (Electromagnetic and Weak)

Refer also to abstract 1676.

1665 THREE-PION DECAY OF η IN THE $SU_2 \times SU_2$ CHIRAL DYNAMICS. Kanazawa, Akira (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto), 40: 430-2(1968).

It is shown that the SU(2) × SU(2) chiral dynamics with PCAC condition fails to explain the $\eta \to 3\pi$ decay process. Two ways to avoid this difficulty are given: one is to introduce the $\eta\eta\pi\pi$ interaction in a way that violates the PCAC for η; the other is to introduce an additional $-4\pi\lambda\phi^4$ interaction combined with the final state interaction in the form of the ρ-meson. The latter case is shown to reproduce the experimental results. (L.B.S.)

1666 ON POSSIBILITY OF THE CP-INVARIANCE VIOLATION IN $K^+ \to \pi^+ + e^+ + e^-$ DECAY. Gnedov, Yu. A. (Sterlitamakskii State Teacher's Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 98-9(1968). (In Russian).

The violation of CP-invariance in electromagnetic–weak processes was studied considering the $K^+ \to \pi^+ + e^+ + e^-$ decay process. The matrix element of the transition without fulfilling the equality of the axial and vector part of the form factors was ex-

pressed by: $\mu = e^2\, GF^{-}$ up $(1 + C\gamma_5)\, vf_1f_2$ (where p is the K^+ meson momentum, e and G are constants of electromagnetic and weak interactions, f_1 and f_2 wave functions of K^+ and π^+ mesons). By neglecting electron mass, the matrix element square $|\mu|^2$ permits a simple description of the degree of transverse polarization. Without the form factor value it is possible to evaluate roughly the transverse polarization magnitude by the hypothesis of CP-invariance violation considering the existence of a new interaction in which CP-parity of the matrix element has an inverse sign to that of CP-parity of electromagnetic interaction matrix element. (R.V.J.)

1667 UNIFIED THEORY OF CP-CONSERVING AND -VIOLATING WEAK INTERACTIONS. Okubo, Susumu (Univ. of Rochester, N. Y.). Ann. Phys. (N. Y.), 49: 219-31(Sept. 1968).

Assuming the intermediate vector meson is a Yang–Mill field, all weak interaction phenomena involving both CP-conserving and violating processes are treated in a unified manner. In this theory, the weak interaction violates CP maximally. Also, a notion of the weak SU(3) space in contrast to the ordinary hadronic SU(3) space is introduced. (auth)

1668 ON THE UNITARITY SUM RULE FOR THE K^0 DECAYS AND CPT VIOLATION. Achiman, Y.; Horwitz, L. P. (Tel-Aviv Univ., Israel). Nuovo Cim., 57A: 863-9(Oct. 21, 1968).

The unitary sum rule for the K^0 decays is used to show that the main results obtained in a CPT-violating model of $K^0 \to 2\pi$ decays with T invariance can be obtained independently of the assumption of T invariance, and that the $\pi\pi$ phase-shift difference $\delta_2 - \delta_1$ may take any value without affecting the relations obtained between η_{+-} and η_{00}. The sum rule is also used to obtain $|\epsilon| \lesssim 10^{-3}$ and $|\delta| \lesssim 10^{-3}$ for both cases $|\langle K_S|K_L\rangle| \lesssim 10^{-4}$ and T invariance assumed independently. This result is shown to be consistent with the order of magnitude for these parameters deduced from charge asymmetry of $K_L \to \pi l \nu$. (L.B.S.)

1669 CP-VIOLATING WEAK CURRENTS. Maiani, Luciano (Istituto Superiore di Sanita, Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 240-4(Feb. 1968). (In Italian).

A theory in which CP is violated through second class axial currents is discussed. These currents are given a suitable algebraic structure so as to maintain the leptons–hadron symmetry in leptonic processes. CP-violations are then described by a universal angle φ, to be determined from experiments. Implications for leptonic and nonleptonic processes are discussed. (auth)

Applications (Strong)

Refer to abstracts 1680 and 1865.

Field Theories

General

1670 HIGHER-DIMENSIONAL FIELD THEORY. Ahner, Henry Frank. New York, New York Univ., 1968. 139p.

Thesis.

Four equations of Physics (the Einstein relativistic field equation, the Dirac equation, the Klein–Gordan equation, and the vector wave equation) are examined, in general, in geometrical spaces that have more than four dimensions. General reasons for considering such spaces are presented. Basic assumptions are listed and previous work in the field examined. A principle of dimensionality minimality is presented and used to limit the number of topological spaces considered. N-dimensional spaces (N > 4) may be split into two smaller spaces whose lower symmetry is determined by the topology assumed for the larger space. The topology is always taken such that one of the smaller spaces is four dimensional with a Poincaré symmetry group. Then the other space can have the Yang–Mills SU(2) isospin symmetry group when N is six and the SU(3) symmetry group when N is eight. Mass formulas for elementary particles are found when the particle equations are examined. The topology of the N-dimensional space is solely responsible for the particle representations which appear. It is shown that quark-triplet particle representations can not exist in the eight dimensional space chosen. Particle representations which may appear are listed. An approximation procedure is developed which may be used to determine the values of the metric components. When it is utilized the SU symmetries are broken but the dimensionality of the particle representations is unchanged. No-Go theorems are not applicable because the Lie groups used have an infinite number of parameters. The formalism is illustrated in detail in six dimensions. When an additional term is added to the N-space vector meson Lagrangian the low mass particle states are seen to comprise the $\pi(137)$ scalar triplet and the $\omega(782)$ vector isosinglet. All previous N-dimensional theories predicted charged particles with masses greater than 10^{21} MeV. Also in six dimensions the ratio of the coupling constants of π and ω mesons to nucleons is predicted. The theory is evaluated and possibilities for further investigation are given. (Disser. Abstr.)

Quantum Field Theory

1671 (LNF–68/42) HIGH-ENERGY EXPERIMENTS ON QED. Note No. 409. Bernardini, C. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). July 8, 1968. 23p. Dep.

A review is given of recent experimental tests of quantum electrodynamics in the high energy region, with emphasis on two-body electromagnetic interactions. A brief summary is first given on the kinematics of two-body reactions using a metric such that $q^2 > 0$ is time-like and $q^2 < 0$ is space like. Experimental results are then summarized and discussed. (L.B.S.)

1672 LOCAL OPERATOR ALGEBRAS IN THE PRESENCE OF SUPERSELECTION RULES. Federbush, Paul (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.), 9: 1718-21 (Oct. 1968).

An introductory study is made of the relation between the local algebra of observables associated to a region of space–time and the algebra of all operators (disregarding superselection rules) associated to the same region of space–time. With a reasonable axiomatization of the problem and assuming the local algebra of observables is a factor of type I, II_∞, or III, the relation between the two algebras is specified up to unitary equivalence in terms of algebraic invariants. (auth)

1673 ALGORITHM FOR REDUCING CONTRACTED PRODUCTS OF γ MATRICES. Kahane, Joseph (Brookhaven National Lab., Upton, N. Y.). J. Math. Phys. (N. Y.), 9: 1732-8(Oct. 1968). (BNL–11973).

A construction algorithm is given which allows any partially contracted product of γ matrices to be reduced in one line to a simple canonical form involving only the uncontracted indices. (auth)

1674 NULL AND PSEUDONULL DATA FOR SCALAR FIELDS. Grgin, Emile (Yeshiva Univ., New York). J. Math. Phys. (N. Y.), 9: 1595-1601(Oct. 1968).

A projective geometric formalism for the description of the conformal compactification of Minkowski space and of its invariance groups is developed. It is then modified to include the description of Minkowskian vectors, in particular, the momentum space. The d'Alembert equation is solved by constructing its solutions from global null data, completely arbitrary numbers assigned to the null cone at infinity. The Klein–Gordon equation, solved by the same method, leads to the concept of pseudonull data. Pseudonull data are also arbitrary numbers, but they are assigned to hyperboloids at a suitably defined infinity outside the conformal compactification of the Minkowski space. (auth)

1675 MASSLESS TENSOR FIELDS AND TRIPOLE GHOSTS. Kubo, Reijiro; Yokoyama, Kan-ichi (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 40: 421-3(1968).

The problem of determining the gauge of massless tensor fields is studied by introducing vector tripole ghost fields. (L.B.S.)

1676 TCP INVARIANCE AND THE DIMENSIONALITY OF SPACE–TIME. Rosen, S. P. (Purdue Univ., Lafayette, Ind.). J. Math. Phys. (N. Y.), 9: 1593-4(Oct. 1968).

The original proofs of the TCP theorem suggest that it may breakdown in an odd-dimensional space–time. An explicit example of this breakdown is given and a comment is made about the current × current interaction. (auth)

1677 NON-LINEAR EFFECT IN QUANTUM ELECTRODYNAMICS. Mitter, H. Phys. Bl., 24: 348-52(Aug. 1968). (In German).

The nonlinear effects introduced in quantum electrodynamics by the superposition of a light source with a slowly changing, strong electromagnetic field are summarized. The principal effects of a single light source with the electromagnetic field are Delbruck scattering, double refraction, and the dichroism of the vacuum. The occurrence of several light sources leads to the problems of fusion or fission of the photons, a modification of the electromagnetic properties of the electrons, and the scattering of light on light. The cross section shows a resonance behavior. (J.S.R.)

1678 PARTICLES AND FIELDS. Lurie, David. New York, John Wiley and Sons, Inc., 1968. 516p. $15.00.

Relativistic one-particle equations, Lagrangian field theory, quantum fields, quantization of spin 1 and spin 3/2 fields, inter-

acting quantum fields, perturbation theory vacuum expectation values and the S-matrix, currents, coupling constants, and sum rules, bound states, and the functional method are studied. (W.H.K.)

1679 METHOD OF CONSTRUCTION OF THE GREEN'S FUNCTIONS IN MOMENTUM SPACE FOR UNRENORMALIZABLE INTERACTIONS. Volkov, M. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.), 49: 202-18(Sept. 1968).

A unitary method is developed for constructing the Fourier transform of the two-point Green's functions in local and nonlocal theories with unrenormalizable interactions. The spectral representations of these functions are derived. It is shown that the functions considered have a logarithmic branch point with respect to g for g = 0 in the momentum space. (auth)

1680 INFINITE MULTIPLETS IN QUANTUM FIELD THEORY. Chi, Cao; Dao Vong Dyc; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Moscow). Ann. Phys. (N. Y.), 49: 173-201(Sept. 1968).

A treatment of some essential results obtained in quantum field theory with infinite multiplets is presented. The explicit expression of the matrix of finite Lorentz transformation is found. The interaction of infinite multiplets is studied and its specific properties are shown. The quantization of fields with infinite multiplets is considered. The generalized Feynman rules are formulated. (auth)

1681 DRESSED VACUUM IN QUANTUM ELECTRODYNAMICS. Rosen, G. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 57A: 870-4(Oct. 21, 1968).

A well-defined approximate solution to the Schroedinger stationary-state vacuum equation $H\phi_{vac} = 0$ is reported. A closed-form expression is derived for the dressed-vacuum state ϕ_{vac} that is accurate to order ϵ^2. (L.B.S.)

1682 COMMENTS ON THE COMPOSITENESS CONDITIONS FOR PARTICLES WITH IDENTICAL QUANTUM NUMBERS. Hayashi, K. (Tokyo Univ.); Hirayama, M.; Seto, N.; Shirafuji, T. Nuovo Cim., 57A: 746-52(Oct. 21, 1968).

For two particles in a single channel with identical quantum numbers, the compositeness conditions are carefully examined. With respect to a choice of the equations to determine the masses and the coupling constants of the particles in question, the following statement is made to be proved in the text; (a) the condition $\lim_{s\to-\infty} s \det Z(s) = 0$ is tenable as the "second" compositeness condition in addition to the "first" one $\lim_{s\to-\infty} \det Z(s) = 0$, where Z(s) denotes the matrix of the wave-function renormalization function and becomes identical with the renormalization constant as s tends to infinity; (b) when the second condition is employed, $D(s)/\mathcal{D}(s)$ must tend to zero as s goes to infinity, where D(s) signifies the denominator function of the total scattering amplitude and $\mathcal{D}(s)$ that of its single-particle irreducible part. Using these results the compositeness conditions are discussed for the present case in close analogy with the case of a single particle in a single channel. (auth)

1683 ON UNIFORM APPROXIMATIONS TO THE SOLUTIONS OF THE PARTIAL-WAVE BETHE–SALPETER EQUATION. Choudhury, M. H. (Univ. of Hull, Eng.). Nuovo Cim., 57A: 617-37(Oct. 21, 1968).

The partial-wave Bethe–Salpeter equation for two equal-mass particles is reduced to infinite systems of linear equations for the two special cases when the spectral function is given by (i) $\sigma(\mu^2) = g^2\delta(\mu^2-\mu_0^2)$, (ii) $\sigma(\mu^2) = g^2\theta(\mu^2-\mu_0^2)[\mu^2-\mu_0^2]^{-\eta+1}$, where $\mu_0^2 > 0$, $0 < \eta < 1$ and $\theta(\mu^2-\mu_0^2)$ is the step function. This reduction seems possible only after the Wick transformation has been applied initially. The coefficients of these systems of linear equations are then analytically continued to all physical values of the energy below the production threshold and involve only single integrals which are easily evaluated numerically. It is found that the linear transformations which these systems of linear equations (with the analytically continued coefficients) define, are compact in Hilbert space for all physical values of the energy up to some value a little below the production threshold. (auth)

1684 CONTINUOUS TENSOR PRODUCTS OF HILBERT SPACES AND GENERALIZED RANDOM FIELDS. Streater, R. F.; Wulfsohn, A. (Imperial Coll. of Science and Tech., London, CNRS, Marseille). Nuovo Cim., 57B: 330-9(Oct. 11, 1968).

The infinite tensor product is generalized to a tensor product of certain Hilbert spaces over a topological index set. The criterion for positivity of characteristic functionals of generalized random processes is used to construct two distinct types of continuous tensor products. Representations of the canonical commutation relations (CCR) are constructed in one of these. The other is seen to be useful in the construction of certain quantum fields. (auth)

1685 SELF-COUPLED GENERALIZED YANG–MILLS FIELDS. Lyakhovskii, V. D.; Tsugulea, M. N. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 10, 7-15(May 1968). (In Russian).

The theory of self-coupled generalized vector fields of Yang–Mills type is examined in detail. Gauge invariance of all the equations and the S-matrix is established. The procedure of normal dependent terms elimination is exhibited. Among other consequences of S-matrix invariance the four-line interaction is shown to be a subsidiary one. The theory is proved to be renormalizable. (auth)

1686 GAUGE-INDEPENDENT QUANTUM ELECTRODYNAMICS. Goldberg, I.; Marx, E. (Drexel Inst. of Tech., Philadelphia). Nuovo Cim., 57B: 485-502(Oct. 11, 1968).

A classical theory of the interaction of a spinor field with the electromagnetic field is presented in which the potentials enter only implicitly through the Maxwell tensor. This theory differs from previous ones in that it is both manifestly covariant under Lorentz transformations and local in time. The quantization is then carried out without a need to introduce special terms or an indefinite metric, and the perturbation expansion of the S-matrix is formulated. (auth)

Gravitation and General Relativity

Refer also to abstracts 1142 and 1147.

1687 EQUATORIAL GEODESIC MOTION IN THE GRAVITATIONAL FIELD ON A ROTATING SOURCE. de Felice, F. (Cambridge Univ., Eng.). Nuovo Cim., 57B: 351-88(Oct. 11, 1968).

The geodesic motion in the gravitational field of a rotating source is investigated, making use of the exact empty-space solutions of Einstein's equations given by Kerr. The earlier weak-field approximate solutions of Lense and Thirring for a rotating body are also examined to compare them with the exact case and with the Schwarzschild nonrotating one, whose geodesic properties are also briefly summarized. The behavior of single orbits, for example the precession of the pericenter, will not be mentioned since they have been extensively analyzed in the cited references. The differential equations of the geodesics are analyzed from an analytical point of view in order to recognize the shape of the loci of the turning points for the test particles without introducing numerical values of the parameters involved such as a (specific angular momentum of the rotating body) and Γ (test particle's effective energy). Diagrams are given which show the behavior of the geodesics for different ranges of these parameters. An attempt is made to make a physical comparison between these three cases. (auth)

1688 FURTHER CONSIDERATION OF ENERGY AND MOMENTUM IN GENERAL RELATIVITY. Moss, M. K. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 57B: 257-70 (Oct. 11, 1968).

The problem of the proper formulation of the conservation laws of energy and linear momentum in general relativity is discussed. The Komar expression, taken as a generally covariant conservation law generator, is considered in light of the problem which Møller found with his energy-momentum complex. The conservation laws as formulated here from the Komar generator are shown to be devoid of such difficulties. Also, a generally covariant formulation of the conservation laws, which are differentiated from a covariant conservation-law generator, is effectively achieved without the necessity of introducing a tetrad structure. In this formulation the conservation laws per se are noncovariant quantities; however, one may always return to the Komar generator and transform in a generally covariant manner any given conservation law, through its underlying symmetry representation, to any space-time co-ordinate system of interest. It is also possible, at least in some simple space-time systems, to formulate the energy and momentum when they are not rigorously conserved entities. Such expressions can have possible application, for example, in radiating gravitational systems. (auth)

1689 PRINCIPLES OF RECIPROCITY AND EQUIVALENCE OF MONADS AND THEIR IMPLICATIONS. Khan, I. (Dublin Inst. for Advanced Studies). Nuovo Cim., 57B: 321-9(Oct. 11, 1968).

Two a priori obvious principles are formulated and their implications are carefully examined. (auth)

1690 ALMOST SYMMETRIC SPACES AND GRAVITATIONAL RADIATION. Matzner, Richard A. (Cambridge Univ., Eng. Univ. of Maryland, College Park). J. Math. Phys. (N. Y.), 9: 1657-68(Oct. 1968).

A generalization of the idea of Killing fields to spaces which are

not symmetric is given. The field so defined specifies coordinate lines along which the variation of the metric tensor is the slowest possible in a global sense. Thus it generalizes the Killing fields in spaces with a symmetry where the metric tensor does not change along Killing trajectories. Several examples are given, and the method is then applied to spaces containing gravitational radiation of the type considered by Issacson. For spaces containing radiation, it is shown that a real functional $\lambda[\xi]$, associated with every vector field ξ, measures some parameters associated with the radiation. In the simplest case this parameter is the "energy density" of the radiation, but, if a sufficient number of vector fields can be invariantly defined in the background, the average gravitational "stress" associated with the wave may also be measured. Some conjectures about further application of these ideas to the theory of gravitational radiation are included. (auth)

1691 GENERAL RELATIVISTIC THEORY OF ONE-DIMENSIONAL LAGRANGIAN FUNCTIONS. PART III. ONE-COMPONENT MASSOR FIELDS. Knapecz, G. (Univ. for Technical Sciences, Budapest). Acta Phys. Acad. Sci. Hung., 24: 403-18 (1968).

Massors are objects which describe the internal energy (mass) of the fields (particles) in a way which is similar to the description of the spin by spinors, vectors, etc. After a brief survey of the mathematical theory of the massors the general relativistic and quantized free unitary massor field model is treated. The rest mass of the field appears spontaneously in the Lagrangian as well as in the equations of motion of the system. The field has charge, which is a scalar, and energy, which is an invariant implet. The energy is copletisable by the charge. The quantized values of the charge are $Q = n$, and those of the energy $T = \varkappa n$, where $\varkappa$ is the rest mass of a quantum, and n equals 0, 1, 2, ... in the case of the Bose–Einstein statistics, or n equals 0, 1 in the case of the Fermi–Dirac one. (auth)

1692 ON SOME ASPECTS OF THE MASS DIPOLE PROBLEM OF A SPECIAL WEYL SOLUTION IN THE EINSTEIN–MAXWELL THEORY. Schmutzer, E.; Nottrott, J. (Univ., Jena, Ger.). Acta Phys. Acad. Sci. Hung., 24: 331-6(1968).

The exterior solution of the Einstein–Maxwell equations, describing all static axisymmetric problems, has been found by Weyl. This so-called Weyl solution has been specialized by Bonnor with respect to a point singularity interpreted as a magnetic dipole, which in certain cases induces a mass dipole. A special calculus of delta functions is used to obtain information about the structure of the singular part of T^i_j of the point source of the field. (auth)

1693 USE OF DELTA FUNCTIONS IN GENERAL RELATIVITY FOR DETERMINATION OF THE INTEGRATION CONSTANTS. Schmutzer, E. (Univ., Jena, Ger.). Acta Phys. Acad. Sci. Hung., 24: 325-30(1968).

During the integration of the Einstein–Maxwell equations, integration constants appear and their interpretation is often very difficult. There is therefore, a requirement for a calculus of delta functions which will automatically relate integration constants to sources. In this paper a calculus of this kind is developed and applied to the spherically symmetric problem. In this way we get a method of distinction between pure mathematical and physicel singularities. (auth)

1694 STATIONARY ELECTROMAGNETIC FIELDS IN GENERAL RELATIVITY. Datta, B. K. (Surendranath Coll., Calcutta); Raychaudhuri, A. K. J. Math. Phys. (N. Y.), 9: 1715-18(Oct. 1968).

Some solutions of the Einstein–Maxwell equations corresponding to a superposed electric and magnetic field at right angles to each other are presented. The solutions are stationary and include the case of null field also. There are, however, some singularities in the metric tensor. (auth)

1695 DISCUSSIONS ON THE GRAVITATION OF A CYLINDRICALLY SYMMETRIC MAGNETIC FIELD. Sen Gupta, R. (Ananda Mohan Coll., Calcutta); Ghosh, R. Phys. Lett., 28A: 11-12 (Oct. 21, 1968).

The line element for a cylindrically symmetric magnetic field was earlier obtained by the authors. The case of a particle moving in circular orbit perpendicular to the axis of a cylindrically symmetric magnetic field is discussed. The pressure in this field is also studied. (auth)

1696 PULSE ENERGY TENSOR AND THE GRAVITATIONAL RADIATION. Dozmorov, I. M. (Lvov State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 130-2(1968). (In Russian).

Radiation problems in the general theory of relativity were studied by means of momentum-energy tensor obtained previously. The invariant criterion applied to the axial-symmetric solution was formulated. The analog between momentum-energy tensors of electromagnetic and gravitational fields was developed and invariant radiation criterion was obtained on the basis of the analog. (R.V.J.)

1697 REALITY OF THE GRAVITATIONAL WAVES. Dozmorov, I. M. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 7, 156-8(1968). (In Russian).

The A. Peres and H. Bondi solutions for free space Einstein equations were evaluated using gravitation field momentum-energy tensor. The data obtained indicated that the Bondi solution described the waves carrying gravitational energy while the Peres solution did not describe the gravitational field because in his case the momentum-energy tensor identically went to zero. It is suggested that the Peres solution represents a space warpage. (R.V.J.)

1698 PARADOXES IN THE THEORY OF RELATIVITY. Terletskii, Yakov P. New York, Plenum Press, 1968. 129p. Translated from Paradoksy Teorii Otnositel'nosti.

The theory and content of the theory of relativity, Einstein's postulates and the Lorentz transformations, paradoxes in kinematics, and paradoxes in relativistic dynamics are discussed. Also, the possibility of the existence of velocities higher than the velocity of light and negative and imaginary proper masses are considered. (W.H.K.)

1699 SPINOR APPROACH TO THE LANCZOS SPIN TENSOR. Maher, W. F. Jr.; Zund, J. D. (North Carolina State Univ., Raleigh, N. C. Univ. of Cambridge, Eng.). Nuovo Cim., 57A: 638-48(Oct. 21, 1968).

The van der Waerden spinor corresponding to the Lanczos spin tensor is obtained and shown to be a spinor of type (3, 1). This spinor, which directly appears in the spinor equivalents of the Weyl and Bell–Robinson tensors, is intimately related to the Petrov classification. By using the dyad formalism of Newman and Penrose this relationship is explicitly exhibited in terms of the spin coefficients, the optical scalars, and the dyad component of the Lanczos spinor. A possible physical interpretation of the Lanczos spinor is proposed. (auth)

1700 IMPROVED THEORY OF GRAVITATION. PART I. Rastall, Peter (Univ. of British Columbia, Vancouver). Can. J. Phys., 46: 2155-79(Oct. 1, 1968).

A theory of gravitation is developed from assumptions that differ as little as possible from those of special relativity and the Newtonian theory of gravitation. As in special relativity, one assumes the existence of preferred coordinate systems (Newtonian charts) in which the nondiagonal components of the metric vanish, and in which the spatial diagonal components are equal. The metric is determined by a single real function, the gravitational potential, which is assumed, as in the Newtonian theory, to be arbitrary to the extent of an additive constant. A uniqueness theorem is proved for Newtonian charts, and the functional dependence of the metric on the gravitational potential is determined (apart from two constants, which are later fixed by requiring that the equations of motion of a particle have the correct, nonrelativistic limit, and that the potential due to a fixed particle have the Newtonian form at great distances). By a simple change in the units of space and time, the geometry is made Minkowskian. A similar change in the units of mass makes the theory formally similar to special relativity. Particle dynamics is developed. The red shift and the deflection of light by a star are calculated, and agree with the Einstein results. The combination of the assumptions that the potentials due to particles are additive and that the potential due to a fixed particle is not proportional to $1/r$, is shown to lead to difficulties. The weight of a simple system is found to be proportional to its total energy, including its gravitational interaction energy. Continuous, static mass distributions are considered. A field equation is derived for the static gravitational potential, and an expression for the energy density of the static gravitational field. The field equation is modified by assuming that the gravitational energy density is itself a source of the gravitational potential. The potential due to a static, spherically symmetric body is calculated, and the perihelion advance of a planet is found to be $^1/_{12}$ of the Einstein value, in good agreement with the results of Dicke. (auth)

1701 REPORT ON THE INVESTIGATION OF MACH'S PRINCIPLE IN THE SCALAR-TENSOR THEORY OF GRAVITY. Toton, E. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 1401-6(Nov. 4, 1968).

Most statements of Mach's principle demand that the mass of a solitary object be zero. The results of self-energy calculations in the canonical formalism of the scalar-tensor theory for solitary neutral point particles and the solitary charged point particle are reported. The results show that from the viewpoint of Mach's principle, the scalar-tensor theory offers no substantial improvement over general relativity. (auth)

Scattering Theory

Refer also to abstract 1642.

1702 (KFKI-18/1968) AN INTRODUCTION INTO THE HIGHER SYMMETRIES OF REGGE-POLES. Sebestyen, A.; Szego, K.; Toth, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Aug. 7, 1968. 30p. Dep.

An introduction into the generalized partial wave analysis is presented. The kinematics of the quasi elastic scattering of particles with different masses is first discussed. Regge theory is then reviewed. The four-dimensional partial-wave analysis of the scattering amplitude is discussed both in the equal and unequal mass case. The analytic properties of a Lorentz-pole contribution are examined in detail. The main properties of the Lorentz group are summarized in the Appendices. (L.B.S.)

1703 (LPTHE-TH-68/14) FACTORIZATION AND CONSTRAINTS IN REGGE-POLE THEORY. Capella, A.; Contogouris, A. P.; Tran Thanh Van, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). May 1968. 13p. Dep.

Non-group-theoretical methods are used to determine the behavior at momentum transfer $\sqrt{t} \to 0$ of the Regge residue functions $\beta_{\lambda_3\lambda_4;\lambda_1\lambda_2}(t)$ of the t-channel reaction $1 + \bar{2} \to \bar{3} + 4$. The solution presented is minimal in the sense that for a trajectory $\alpha(t)$ of known quantum numbers it gives the most singular behavior of $\beta_{\lambda_3\lambda_4;\lambda_1\lambda_2}(t)$ compatible with analyticity requirements and the factorization theorem. The solution is used to show that at least in the cases, (i) $N + \bar{N} \to N + \bar{N}$, (ii) $N + \bar{N} \to \bar{3} + 4$ where 3 and 4 are particles of arbitrary spin and $m_3 \neq m_4$, (iii) $m_1 \neq m_2$ and $m_3 \neq m_4$, all the kinematical constraints at $t = 0$ to all orders can be satisfied to all orders in $s \equiv (p_1 + p_2)^2$. In particular, for a situation which corresponds to the group-theoretical class III, parity doubling is deduced. (L.B.S.)

1704 (LPTHE-TH-68/15) REGGE BEHAVIOR, KINEMATICAL SINGULARITIES AND FIXED POLES. Caser, S.; Basdevant, J. L. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). June 1968. 10p. Dep.

It is shown that the problems of daughter trajectories, conspiracy, and evasion are closely related to the existence of fixed poles in angular momentum. If fixed poles are discarded, then daughters, conspirators or vanishing residues, occur. This is obtained by assuming the scattering amplitude below threshold to be given by a dispersion integral on the Regge behavior above threshold. (auth)

1705 (LPTHE-TH-68/21) DEDUCTION OF TOLLER'S CLASSIFICATION FROM ANALYTICITY OF HELICITY AMPLITUDES AND FACTORIZATION. Capella, A.; Contogouris, A. P.; Tran Thanh Van, J. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). July 1968. 8p. Dep.

The group-theoretical classification of Regge trajectories is deduced from the analyticity properties of the individual helicity amplitudes and the factorization theorem. (auth)

1706 (UCD-CNL-101) OPERATOR REDUCTION OF THREE-BODY SCATTERING EQUATIONS. Kazaks, Peter A. (California Univ., Davis. Crocker Nuclear Lab.). Aug. 1968. Contract AT(11-1)-Gen-10. 64p. Dep. CFSTI.

Operator multipliers of the Lippmann-Schwinger (L-S) equation are used to obtain calculable and unique solutions. The multiplier method is used as a basis for determining the relation between various formulations of the three-body problem. The properties of the multipliers determine whether the multiplied equation yields fewer, extra, or unchanged bound state solutions. It is pointed out that the noncompact kernel of the L-S equations for three-body problems both renders the solutions incalculable and produces non-unique solutions for the wave functions. The method proposed by Sugar and Blankenbecler to make the kernel compact is examined. It is found that the inverse of their arbitrary operator L must exist in order to not reduce the number of bound states. Using a specific operator L or M as a multiplier of the L-S equations formal but calculable solutions are obtained. The operator manifestly cancels the non-compact part of the L-S kernel and introduces neither fewer nor spurious bound state solutions since its inverse exists and is known. It is then found that the formal but calculable solutions of the three-body scattering formulations of Faddeev, Rosenberg, Lovelace, Newton and Noble are identical to each other and identical to the solution of the multiplied L-S equations. The multiplier method is used to obtain a criterion for the spurious bound states introduced by the Weinberg formulation of three-body scattering. This new criterion is an integral equation involving only the potentials of the problem. To indicate its usefulness and applicability, the multiplier method is used in discussing corrections to the distorted wave and shell model approximations. (auth)

1707 DIRAC FORMALISM FOR ARBITRARY SPIN IN S-MATRIX THEORY. Enflo, B. O. (Univ. of Stockholm); Laurent, B. E. Fortschr. Phys., 16: 373-418(1968).

The S-matrix formalism is built up from the beginning, for particles with and without mass, through systematic use of the representation $D_{s,0} \otimes D_{0,s}$ of the homogeneous Lorentz group. Only concepts referring to space and time are considered. Within the framework of the formalism, the close interdependence between CPT, spin and statistics, crossing symmetry and unitarity is explicitly emphasized. The concepts of intrinsic parity, spin-flip and particle conjugation are re-examined. A comparison is made with conventional field-theoretic formalism. (auth)

1708 INVERSE FUNCTIONS OF THE PRODUCTS OF TWO BESSEL FUNCTIONS AND APPLICATIONS TO POTENTIAL SCATTERING. Mavromatis, H. A.; Schilcher, K. (American Univ. of Beirut). J. Math. Phys. (N. Y.), 9: 1627-32(Oct. 1968).

Inverse functions of products of two Bessel functions $j_l(xy)j_m(xy)$ are determined for the cases $m = l$, $l + 1$, and $l + 2$. Integral representations for these inverse functions in terms of Neumann functions are given, and some of the simplest ones are expressed in terms of trigonometric functions. It is shown how one may obtain an integral representation for any well-behaved function in terms of products of two Bessel functions, with the help of these inverse functions and also outline some of their applications to potential scattering. In particular, the usefulness of the inverse functions in determining the potential explicity from the phase shifts in the Born approximation is demonstrated. (auth)

1709 HIGH-ENERGY FIXED-ANGLE POTENTIAL SCATTERING. Johnson, Porter (Case Western Reserve Univ., Cleveland). J. Math. Phys. (N. Y.), 9: 1633-8(Oct. 1968).

The asymptotic behavior of the scattering amplitude $f(k,\theta)$ at high-momenta k for fixed (nonforward) scattering angles θ is studied. The considerations here are limited to the class of potentials for which the momentum-space representations $V(q)$ decrease less rapidly than some inverse power of q as $q \to \infty$ through positive real values. Some additional relatively simple conditions are placed upon $V(q)$ for $q > 0$ which are sufficient to guarantee that the asymptotic limit of f for large k with fixed θ is, in fact, the first Born approximation $f_1(k,\theta)$. (auth)

1710 CROSSING, HERMITIAN ANALYTICITY, AND THE CONNECTION BETWEEN SPIN AND STATISTICS. Stapp, Henry P. (Univ. of California, Berkeley). J. Math. Phys. (N. Y.), 9: 1549-92(Oct. 1968).

The analytic S-matrix framework is further developed. First some results of earlier works are collected and the physical-region analyticity properties recently derived from macroscopic causality conditions are described. These entail that scattering functions are analytic at physical points except on positive-α Landau surfaces, and that there they are $i\epsilon$ limits of analytic functions from certain well defined directions, except possibly at certain points where four or more positive-α surfaces intersect. A general $i\epsilon$ rule that also covers these exceptional points is then stated. It is then shown that the scattering function defined by analytic continuation is either symmetric or antisymmetric under interchange of variables describing identical particles and that the sign induced by the interchange is independent of the particular scattering function in which the variables appear. The physical-region analyticity properties of bubble diagram functions are then derived from the general $i\epsilon$ rule. These functions are products of scattering functions and conjugate scattering functions integrated over physical internal-particle variables, as in the terms of unitarity equations. They are shown to be analytic in the physical region except on Landau surfaces and, more specifically, except on those Landau surfaces that correspond to Landau diagrams that are supported by the bubble diagram in question, with the further restriction that the Landau α's must be positive or negative for lines lying within positive or negative bubbles, respectively. Also, the basic rule for continuation around these singularities is derived. A new general derivation of the pole-factorization theorem is given, which is based on slightly weaker assumptions than earlier proofs. Particular attention is paid to the overall sign. A general derivation of the crossing and Hermitian analyticity properties of scattering functions is then given. On the basis of the deduced general rules for constructing the paths of continuation that connect the crossed and Hermitian conjugate points, the various related points are found to be boundary values of a single physical sheet. In particular, a certain sequence of continuations is shown to take one back to the original point. From this fact it follows that abnormal statistics are incompatible with simultaneous unitarity in both the direct and crossed channels. The proof given here does not depend on the notion of interchange

of variables other than those of identical particles. Earlier proofs depended on the unphysical notion of interchange of variables representing conjugate particles. Finally it is shown that the analytically continued M functions with normal-ordered variables are precisely the scattering functions: no extra signs are needed or permitted. Aside from the general i rule, the analyticity assumptions are these: (1) The discontinuity around a singularity of a bubble diagram B has no residue at a physical-particle mass value (in an appropriate variable) unless the singularity corresponds to a diagram that is supported by B and has the single-particle-exchange form that corresponds to a pole at that mass value. (2) The residue just described has the pole-factorization property. (3) Confluences of infinite numbers of singularity surfaces do not invalidate the results established by assuming that this number is locally finite. Assumption (1) entails that all relevant singularities of scattering functions lie on Landau surfaces. That is the basic assumption. (auth)

1711 CROSSED CHANNEL O-TYPE REGGE POLES. Murai, Nobuyuki (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 40: 423-5(1968).

The contribution of O-type poles to a forward scattering amplitude of two spinless particles is estimated. (L.B.S.)

1712 ASYMPTOTIC FORM FACTORS AND SCATTERING AMPLITUDES. Brout, R.; Englert, F. (Univ. Libre, Brussels). Phys. Lett., 27B: 647-9(Oct. 14, 1968).

The field theoretic formulation of the bootstrap and pole dominance is used to investigate rapidly decreasing form factors and high energy scattering amplitudes in the region of large momentum transfer. (L.B.S.)

1713 SOLUTION OF THE MULTICHANNEL COLLISION PROBLEM BY THE QUASIPARTICLE METHOD WITHOUT THE USE OF FADDEEV'S THEORY. Grassberger, P.; Sandhas, W. (Univ., Bonn). Z. Phys., 217: 9-23(1968).

Exact effective two-particle equations are derived for the composite particle collision problem without reference to the Faddeev theory. This is accomplished by application of the quasiparticle idea to the subsystem operators occurring in the kernel of the multiparticle resolvent (Lippmann-Schwinger) equation. Similar treatments have been put forward already in the framework of Faddeev's theory. The present investigation, however shows that the method is neither restricted to this starting point, nor even typical for this approach. Being closely related to the separable potential approximation it generalizes this model rather directly by including "small" nonseparable rest parts of the potentials iteratively. (auth)

1714 GENERALIZED INTERFERENCE MODEL WITH INDEFINITELY RISING REGGE TRAJECTORIES. Kupsch, J. (Univ., Bonn). Z. Phys., 217: 58-62(1968).

A class of analytic crossing-symmetric amplitudes is constructed which is compatible with any Regge trajectory bounded by $|\alpha(s)| < c \cdot \exp |s|^q$, $q < \frac{1}{2}$. There are examples with an infinite number of Regge poles and without cuts. The model shows that the restrictions on the Regge trajectory and the residue function by analyticity and crossing symmetry are extremely weak. (auth)

1715 HIGH-ENERGY CONSTRAINTS ON THE SCATTERING AMPLITUDE FOR SMALL VALUES OF THE MOMENTUM TRANSFER. Wit, Romuald (Univ., Krakow). Postepy Fiz., 19: 371-82(1968). (In Polish).

A short review of the near-forward properties of the two-body scattering amplitude in the high-energy region, following from unitarity and analyticity, is given. (auth)

1716 EVIDENCE FOR THE FACTORIZABILITY OF THE POMERANCHUK SINGULARITY. Freund, Peter G. O. (Univ. of Chicago). Phys. Rev. Lett., 21: 1375-6(Oct. 28, 1968).

High-energy elastic scattering and diffraction-dissociation data are shown to provide evidence for the factorizability (within 25%) of the Pomeranchuk singularity. (auth)

1717 SOME RESULTS ON MANY-BODY SCATTERING THEORY. Federbush, Paul (Univ. of Michigan, Ann Arbor). Ann. Phys. (N. Y.), 49: 232-43(Sept. 1968).

Several problems are considered related to the study of the T-matrix in the many-body scattering situation. Expanding previous results, the T-matrix is studied outside the realm of perturbation theory, with relation to establishing its analytic properties under the rotation of the final momenta from real to complex values, $k \to (1 + \theta)k$. The geometry of the contour distortion is expressed so as to involve nonperturbative T-matrix element subblocks with incoming and outgoing momenta uniformly rotated. An unrelated elementary Hilbert space argument is given to bound the contributions of high-energy intermediate states to the resolvent identity. (auth)

1718 REGGE POLE VS. RESONANCE DUALITY AND BOOTSTRAP CALCULATIONS. Corgnier, L.; D'Adda, A.; Prastaro, A. (Univ., Turin). Nuovo Cim., 57A: 881-5(Oct. 21, 1968).

The Regge pole vs resonance duality is used to make bootstrap calculations by comparing the behavior of a Regge-like amplitude at fixed scattering angle with that of a sum of resonance contributions. (L.B.S.)

1719 FAMILIES OF REGGE TRAJECTORIES AT NON-VANISHING ENERGY. II. Domokos, G.; Suranyi, P. (Central Research Inst. for Physics, Budapest). Nuovo Cim., 57A: 813-29(Oct. 21, 1968).

A bound-state formalism for a broken trajectory generating algebra is developed. At nonzero energy the "wave function" of a Regge state is represented as a reducible representation of the zero-energy trajectory generating algebra. Perturbation formulas in the total energy for families of Regge trajectories and residues are obtained, their algebraic structure is analyzed. A family of trajectories is phenomenologically parametrized in the Chew-Frautschi approximation by three or four parameters. (auth)

1720 PHOTONS IN S-MATRIX THEORY. II. SYSTEMS WITH MANY CHARGED PARTICLES. Storrow, J. K. (Cambridge Univ., Eng.). Nuovo Cim., 57A: 763-76(Oct. 21, 1968).

The results of a previous paper are generalized to systems of many charged particles. It is shown that the infrared divergences of field theory can be eliminated for a general process by taking the appropriate amplitude. The one-particle singularity due to a neutral particle is studied and is found not to be a pole in general. Cluster decomposition properties of the S-matrix are studied and found to be the same as for strong interactions, apart from a pole in the forward direction. (auth)

1721 ASYMPTOTIC BEHAVIOUR OF THE COULOMB-NUCLEAR S-MATRIX IN THE LEFT-HALF λ-PLANE. Shastry, C. S. (Saha Inst. of Nuclear Physics, Calcutta); De, Alok. Nuovo Cim., 57A: 665-77(Oct. 21, 1968).

Asymptotic behavior of the Coulomb-nuclear S-matrix for a Yukawa type "nuclear" potential is discussed using the behavior of Jost solutions for large values of angular momentum in the left-half λ-plane. The advantages of studying the Jost solution instead of the regular solution are examined. Applicability of the methods of Olver in studying the asymptotic solution is also taken into account. The asymptotic behavior of the S-matrix given by $S(\lambda, k) = O(\exp[2\pi i\lambda])$ (divergent along the negative imaginary axis) is replaced by the general asymptotic behavior $|S(\lambda, k)| = O(1)$ in the left-half angular-momentum plane. The results for the pure nuclear problem form a special case of our results. (auth)

1722 ON UNIFORM APPROXIMATIONS TO THE SOLUTIONS OF THE PARTIAL-WAVE LIPPMAN–SCHWINGER EQUATION. Choudhury, M. H. (Univ. of Hull, Eng.). Nuovo Cim., 57A: 601-16(Oct. 21, 1968).

The partial-wave Lippman–Schwinger equation for a superposition of Yukawa potentials for two specific forms of the weight function is reduced to infinite systems of linear (algebraic) equations for the two cases considered. It is shown that the linear transformations which these systems of linear equations define are compact in Hilbert space for physical values of the energy. (auth)

1723 ON LEVINSON'S THEOREM WHEN GHOSTS ARE PRESENT. Nagy, K. L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung., 24: 433-5(1968).

From Levinson's theorem for potential scattering it is known that the scattering phase difference between threshold and infinite energies $\delta_{thresh} - \delta_\infty = \pi(N - N_e)$, where N is the number of the eigenstates of the total, N_e is that of the number of the unperturbed Hamiltonian. Thus $N - N_e$ is the number of bound states. This relation is investigated using the Lee model with ghosts where the number of interpolating fields is not equal to the number of real particles. (C.E.S.)

Particle Accelerators

Refer also to abstracts 1573, 1613, 1882, and 1929.

1724 (AD-670536) QUARTERLY PROGRESS REPORT, DECEMBER 1, 1967–FEBRUARY 29, 1968. (Harvard Univ., Cambridge, Mass. Cyclotron Lab.). Contract Nonr-1866(56). 10p. CFSTI.

Brief summaries are given of the progress of work in the following areas: cyclotron operation; knockout reactions; neutron total cross sections; n-p total cross sections; biological uses of

proton beams; space radiation studies; measurement of cross sections with neutrons as targets; nuclear resonance in solid H_2; application of synchrotron radiation; directional correlations and Moessbauer effect; studies of resonant absorption of ^{119}Sn at low temperatures; masses of isotopes; induced changes in radioactive decay constants; nuclear interactions in molecules; and atomic hydrogen maser. (auth) (USGRDR)

1725 (BNL-12937) AN ENRICHED PARTICLE BEAM USING SUPERCONDUCTING RF DEFLECTORS. Brown, H. N. (Brookhaven National Lab., Upton, N. Y.). [1968]. 20p. Dep. CFSTI.

A two-cavity superconducting rf beam separator for use at the Brookhaven AGS is described. The separator is designed to produce separated or at least enriched secondary beams for use in counter experiments. Source emittance definition, angular separation, purification, and beam matching to detector are discussed. (W.H.K.)

1726 (JPRS-46672) SEVENTY-GeV PROTON SYNCHROTRON. Basov, Aleksandr Ivanovich. Translated from pp 1-13 of Protonnyy Sinkhrotron na 70 GeV, Serpukhov, USSR, 1967. 14p. CFSTI.

The design parameters of the Serpukhov 70-GeV proton synchrotron are discussed. Topics include the injection system, power supply system of circular magnet, acceleration system, and extracted beams. The basic parameters of the accelerator are listed. (B.G.D.)

1727 (LA-3963) PROCEEDINGS OF THE FIRST LAMPF USERS' MEETING, LOS ALAMOS, NEW MEXICO, JUNE 20, 1968. Emigh, C. Robert; Harper, Katherine H. (eds.) (Los Alamos Scientific Lab., N. Mex.). Sept. 1968. Contract W-7405-eng-36. 66p. (CONF-680633). Dep. CFSTI.

Three papers of an administrative nature were presented on planned management of the facility and its relation to participating users' groups, structure of users' organizations, and the role of Associated Western Universities. Four technical papers were also presented. These were on muon experiments, pion experiments, secondary beam channel transport systems, and proton experiments at SAEL. (B.G.D.)

1728 (NYO-910-72) BIOLOGICAL EFFECTS OF RADIATION AND RELATED BIOCHEMICAL AND PHYSICAL STUDIES. PROPOSAL NO. 4. CYCLOTRON FACILITY AND RADIONUCLIDE PRODUCTION. Progress Report, May 1, 1967-May 1, 1968. Laughlin, John S.; Tilbury, Roy S.; Mamacos, James P. (Sloan-Kettering Inst. for Cancer Research, New York). Sept. 30, 1968. Contract AT(30-1)-910. 40p. Dep. CFSTI.

The design, operation, and performance characteristics of the multi-particle cyclotron at the Sloan-Kettering Institute for Cancer Research are discussed. The experimental facilities including targets and scattering chambers are described. The use of the cyclotron for production of radioisotopes, radioactive gases, and carbon-11-labeled organic compounds is examined. (B.G.D.)

1729 (ORNL-4322) HIGH-ENERGY MUON TRANSPORT AND THE MUON BACKSTOP FOR A 200-GeV PROTON ACCELERATOR. Alsmiller, R. G. Jr.; Leimdorfer, M.; Barish, J. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 35p. Dep. CFSTI.

High-energy muon transport calculations are presented, and the shape of the muon backstop required for a 200-GeV proton accelerator is determined. Results obtained using several different transport approximations are given and compared. (auth)

1730 WEAK FIELD IONIZER FOR A SOURCE FOR POLARIZED DEUTERONS AT POTENTIAL. Haering, F.; Fick, D. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods, 64: 285-92 (Oct. 1968). (In German).

A weak field ionizer of the Weiss-type, but with 2 symmetric cathodes, has been constructed. The general features of this design are discussed. It turns out that one gets a maximum ionization efficiency if one works with a saturation characteristic of the cathodes. In the rest gas of the ionizer we got an ion beam of the order of 1.5 A/Torr. (auth)

1731 APPLICATION OF CONFORMAL MAPPING TO EVALUATION AND DESIGN OF MAGNETS CONTAINING IRON WITH NONLINEAR B(H) CHARACTERISTICS. Halbach, K. (Univ. of California, Berkeley). Contract W-405-eng-48. Nucl. Instrum. Methods, 64: 278-84(Oct. 1968).

It is shown that for evaluation of two-dimensional magnets with nonlinear iron in a conformally transformed geometry, only minor changes of the magnetostatic equations are required. The advantages resulting from evaluation or design of a magnet in a suitably transformed geometry are discussed in detail. (auth)

1732 QUANTUM DESCRIPTION OF A MAGNETIC PRISM. Bosi, G. (Univ., Moncton, Canada). Nucl. Instrum. Methods, 64: 297-300(Oct. 1968).

The quantum treatment of the magnetic deflection of charged particles is discussed. The treatment is confined to non-relativistic ions and is extensively applied to the simplest type of magnetic prism. Quantum formulae should be most useful when dealing with wide beams and investigating their telescopic shapes, for numerical calculations are much simplified when asymptotic formulae are used. (auth)

1733 INTENSITY ESTIMATION FOR CYCLOTRONS. Holm, S. (CERN, Geneva). Nucl. Instrum. Methods, 64: 317-22(Oct. 1968).

A calculation of the minimum value of the focusing force near the center in a cyclotron is made assuming magnetic as well as electric focusing. By equating the vertical space-charge force and the minimum focusing force, expressed as a function of the starting phase angle, the intensity limit is determined by an integration over the starting phase interval. The current is found to vary with the $^3/_2$-power of the dee voltage in cw-cyclotrons, and proportionally to the dee voltage times the repetition rate in synchro-cyclotrons. In the weak focusing synchro-cyclotron, a high slope of the magnetic field in the center is favored. The optimum value of the initial equilibrium phase depends on the injected phase range as well as on the magnetic field law, and is found quite close to the phase of zero energy gain. (auth)

1734 METHOD OF COMPUTING MAGNET COIL CURRENT SETTINGS FOR THE NRL ISOCHRONOUS CYCLOTRON. Allas, R. G.; Davisson, C. M.; Pieper, A. G.; Theus, R. B. (Naval Research Lab., Washington, D. C.). Nucl. Instrum. Methods, 64: 333-45(Oct. 1968).

In order for the modern isochronous cyclotron to accelerate ions of different mass and charge state to a variable final energy, the magnetic field in the accelerating region must be precisely tailored. A deviation of 15 G in 18 kG may lead to a loss of beam. The approximate magnetic field of the NRL cyclotron for isochronous acceleration is achieved by iron pole pieces arranged in a 3-sector hill-valley configuration. This basic field may deviate from that necessary for isochronous acceleration by two or more kG at some radii. Compensation for this field error is achieved by various current-carrying coils wound in the magnet gap. The extent of the magnetic field measurements and the computer program developed at NRL for computing operational parameters (knob-settings) for all current-carrying coils are discussed. Innovations introduced in the calculations include minimizing the first harmonic introduced by the extraction elements and imperfections of the iron. In addition, allowance is made for the lack of linear independence of the trim coils as well as for the perturbation of the flutter field due to the trim coils. The influence of the extraction elements on the accelerating region and the function of each element for beam extraction is also discussed. Measurements on the internal and external beam verify the calculations. (auth)

1735 PROPERTIES OF SOME USEFUL TWO-DIMENSIONAL MAGNETIC FIELDS. Lobb, D. E. (Univ. of Victoria, B. C., Canada). Nucl. Instrum. Methods, 64: 251-67(Oct. 1968).

The potentials and field vectors for a two-dimensional magnetic field of multipolarity $2\underline{N}$ are derived. The usual results for quadrupoles (N = 2), sextupoles (N = 3) and octupoles (N = 4) are obtained by substituting the appropriate value of N into the general equations. The paraxial equations of motion for charged particles in these fields are derived. The magnetic field produced by $2\underline{N}$ parallel current elements equally spaced on the surface of a right circular cylinder is calculated, it is shown that this produces an approximation to a pure multipole field, with the approximation improving as N increases. It is also shown that among the various possible multipole field configurations, the quadrupole provides the strongest focusing effect for given power losses in the source coils. (auth)

1736 TROCHOIDAL ELECTRON MONOCHROMATOR. Stamatovic, A.; Schulz, G. J. (Yale Univ., New Haven). Rev. Sci. Instrum., 39: 1752-3(Nov. 1968).

The development of a trochoidal electron monochromator which employs crossed electric and magnetic fields for low-energy electron beams is described. (W.H.K.)

1737 ELECTRON BOMBARDMENT ION SOURCE FOR LOW-ENERGY BEAMS. Dworetsky, S.; Novick, R.; Smith, W. W.; Tolk, N. (Columbia Univ., New York). Contract DA-28-043-AMC-00099(E). Rev. Sci. Instrum., 39: 1721-3(Nov. 1968).

A high current, electron bombardment ion source of simple design and suitable for low energy ion beam production is described. The source produces ion beams in the energy range

from a few electron volts to several kiloelectron volts with an energy spread of a fraction of 1 eV, with high current density (5 $\mu A/cm^2$ at 25 eV), and without the problems associated with rf ion sources. The source has been used successfully to produce low energy beams of noble gas ions such as He^+ and Ar^+ without metastable contamination, as well as for H_2^+ and N_2^+. (auth)

1738 ENERGY DISTRIBUTION OF POSITIVE IONS EXTRACTED FROM A HOT CATHODE GAS DISCHARGE ION SOURCE. Theard, Lowell P. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Rev. Sci. Instrum., 39: 1639-44(Nov. 1968).

An electrostatic parallel plate energy analyzer was used for measuring the energy distribution of Ar^+ ions in a beam extracted from a nonmagnetic, hot cathode, gas discharge ion source under various conditions of source pressure, anode voltage, and anode current. A large number of energy distribution curves were obtained as X–Y recordings. The curve shape depends upon source conditions, though not strongly when the pressure is greater than 3×10^{-3} Torr with an anode voltage above 50 V (for argon) and an anode current of at least 200 mA. When conditions are optimum, the ion energy distribution curve is a narrow peak with a tail that gradually diminishes towards lower energies over an interval of approximately 30 eV. The actual value of the optimum full width at half maximum was found to be 1.1 eV by extrapolation to zero beam energy. The shape of the curve is such that more than 81% of the beam ions have energies within a 10 eV interval. The source can be used to increase beam currents greatly in certain types of magnetic deflection mass spectrometers without extreme loss of mass resolution due to ion beam energy spread. (auth)

1739 SIMPLE EMISSION CURRENT REGULATOR. Burt, J. A. (York Univ., Toronto). Rev. Sci. Instrum., 39: 1759(Nov. 1968).

An electron emission current regulator is described for stabilizing the electron beam in an electron-impact ion source. (W.H.K.)

1740 NEUTRAL PARTICLE BEAM ACCELERATOR HAVING TRANSVERSE ELECTRODES AND STEERING MEANS FOR THE PARTICLE BEAM. Wharton, Lennard (to Research Corp.). U. S. Patent 3,402,358. Sept. 17, 1968. Filed Nov. 9, 1964.

A neutral particle accelerator is defined by a source of neutral particles and axially spaced electrode pairs whose electric fields polarize neutral particles. Successive electrode pairs are angularly spaced ninety degrees from each other for a beam focusing effect. Dipolar doublets, spaced along the particle beam path, also focus the particle beam. The spaced electrode pairs are operated at the same electric phase. (auth)

1741 STRONG FIELD IONIZER FOR AN ATOMIC BEAM POLARIZED ION SOURCE. Glavish, H. F. (Univ. of Auckland, New Zealand). Nucl. Instrum. Methods, 65: 1-7(Oct. 15, 1968).

A strong field ionizer which employs electron impact ionization is described. A high efficiency is obtained using a hollow electron beam coaxial with the atomic beam and confined by a strong magnetic field. The general features of strong field ionization are discussed. Methods which may lead to an improved efficiency are mentioned briefly. (auth)

1742 BEAM EMITTANCE MEASUREMENTS ON THE FRASCATI 10 MeV MICROTRON. Bordoni, F. (Univ., Catania, Italy); Letardi, T.; Placidi, M. Nucl. Instrum. Methods, 65: 72-6(Oct. 15, 1968).

A method used to measure the emittance of the beam from a 10 MeV microtron in operation at Laboratori Nazionali di Frascati is described. A preliminary set of results, for the actual operating point of the machine, is reported. A systematic investigation will be carried out in the near future taking into account the features of the machine. (auth)

1743 MONTE CARLO CALCULATION OF THE TOTAL ENERGY LOSS OF ELECTRONS FROM 0.3 TO 1 MeV IN ALUMINIUM FOILS. Hara, E. (Hitachi Central Research Lab., Tokyo). Nucl. Instrum. Methods, 65: 85-92(Oct. 15, 1968).

Since low-energy electrons straggle in the beam extraction window, their total energy loss in this window cannot be given by the product of the theoretical energy loss rate of electrons passing through matter, and the foil thickness. This energy loss is calculated by the Monte Carlo method, including the energy loss by knock-on collisions and the difference between real path length and foil thickness. The total energy loss thus obtained is, for instance, about two times as large as the product of the theoretical energy loss rate based on Bethe's formula and the foil thickness, for an initial energy of 300 keV and a foil, 150 μm thick, made of Al, and decreases gradually with increasing initial energy up to about 1 MeV, while the theoretical energy loss rate is almost constant for electrons having kinetic energy above ≈300 keV. (auth)

1744 MOMENTUM MEASUREMENT AT 100 MHz OF PARTICLES IN A HIGH-ENERGY BEAM WITH LARGE ANGULAR DIVERGENCE AND SPATIAL EXTENT. Zajde, C. (Harvard Univ., Cambridge, Mass.); Engels, E.; Hoffman, C.; Innocenti, P. G.; Liberman, A.; Wilson, Richard; Blanpied, W. A.; Stairs, D. G.; Drickey, D. Nucl. Instrum. Methods, 65: 93-100(Oct. 15, 1968).

A method is described for measuring, with counters and fast electronics, the momentum of particles in a high energy beam which has a large spatial and angular spread. The beam is sent through a deflecting magnet and hodoscopes are used at three points along the trajectory. The momentum is inversely proportional to a function that is linear in the positions of the particle in the three hodoscopes and independent of incident particle angle. The main feature of our method is that this linear function can be produced by appropriate summing of the counter discriminator signals. The pulse height of the resulting signal can be used to isolate particles in any given momentum region; the signal rate, up to 100 MHz, implies it can be used in subsequent fast logic. We discuss the application of this technique to a muon beam of 11 GeV/c nominal momentum which was 15 cm in size and with 20 mrad angular divergence. (auth)

1745 PARTICLE ACCELERATING TUBE HAVING AXIALLY LOCALISED TRANSVERSE MAGNETIC FIELDS AND FIELD-FREE REGIONS. Howe, Frederick Albert; Bell, Ronald Inch. (to United Kingdom Atomic Energy Authority). U. S. Patent 3,402,310. Sept. 17, 1968. Priority date Nov. 19, 1964, Great Britain.

A linear particle accelerating tube including an arrangement for deflecting electrons to minimize the phenomenon known as electron loading. The arrangement includes a plurality of spaced apertured electrodes and at least two pairs of devices for producing axially localized transverse magnetic fields separated from one another by substantially field-free regions, each successive pair of localized fields being oriented to deflect the accelerated particle beam from one selected path substantially parallel to the tube axis to another selected path substantially parallel to the tube axis. The paths are selected to minimize the net displacement from the tube axis of the beam emerging from the tube while deflecting the unwanted electrons into the electrodes. (U.S. Pat. Gazette)

1746 FORCED SYNCHROTRON RADIATION OF ELECTRONS IN A HOLLOW CYLINDRICAL RESONATOR. Grigor'ev, V. P.; Privezentsev, A. P. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 154-6(1968). (In Russian).

Forced radiation in resonators and the influence of resonator parameters on the forced radiation energy are studied. The forced synchrotron radiation of charged particles in motion along the periphery of a cylindrical resonator which is placed in a constant homogeneous magnetic field with intensity H and excited by an external generator is considered. It is assumed that the magnetic field is directed along the resonator axis and the cylindrical coordinate system is placed so that the axis z coincides with the resonator axis and the electron orbit is in the plane z = 0. The forced radiation is produced by the external magnetic field perturbation of the electron motion. (R.V.J.)

1747 HIGH ENERGY CHARGED PARTICLE PULSE LENGTH AND ENERGY CONTROL APPARATUS. Haimson, Jacob; Nunan, Craig S. (to Varian Associates). U. S. Patent 3,402,357. Sept. 17, 1968. Filed Sept. 28, 1964.

Controlled variations in pulse length and pulses of uniformly energetic charged particles are chopped out of a cathode pulse in a system utilizing two pair of thyratron controlled deflection plates, a magnetic field orthogonal to the second pair of plates downstream from the first pair and a high energy dissipating V-slotted apertured beam collector. Selected portions of a cathode pulse are chopped out by controlled discharge of thyratrons connected to one of each pair of positively charged deflection plates. Discharge of the upstream thyratron permits the beam to pass undeflected through the aperture. Discharge of the downstream thyratron permits the magnetic field to deflect the beam into the high energy dissipating V-slotted beam collector. By such apparatus, uniformly energetic pulses of charged particles of lengths down to a fraction of a nanosecond, e.g., $1/32$ nanosecond, have been obtained. (auth)

1748 MONITORING SYSTEM TO MEASURE THE ABSOLUTE LUMINOSITY OF A MACHINE OPERATING WITH e^+, e^- COLLIDING BEAMS. Barbiellini, Guido; Borgia, Bruno; Conversi, Mar-

cello; Santonico, Rinaldo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 44: 233-9(Feb. 1968).

A monitoring system based on Bhabha or Moeller scattering ($e^+e^- \rightarrow e^+e^-$) is described. It has been developed in view of an experimental investigation to be carried out with the Frascati storage ring Adone, on the reaction $e^+e^- \rightarrow \mu^+\mu^-$. (B.G.D.)

1749 TRAPPING OF A 0.5-MeV ELECTRON RING IN A 15-kG PULSED MAGNETIC MIRROR FIELD. Trievelpiece, A. W.; Pechacek, R. E.; Kapetanakos, C. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 21: 1436-8(Nov. 11, 1968).

A 6-cm-diam, 3-keV ring of approximately 10^{10} electrons is trapped in a pulsed magnetic mirror field when the midplane field is 60 G. The midplane field rises to 15 kG in 1.0 msec, and the ring is compressed adiabatically to a mean energy of 0.5 MeV. The ring remains trapped for more than 10 msec without observable loss of electrons. (auth)

1750 SLAC HIGH POWER QUANTAMETER. Anderson, R. L. (Stanford Linear Accelerator Center, Calif.). Nucl. Instrum. Methods, 65: 195-8(Nov. 1, 1968).

A non-saturating quantameter for use with the full SLAC photon beam is described. The quantameter is expected to be operable up to a power level of 10 kW although it has only been tested to date up to 3.5 kW. The quantameter is not an absolute device and has to be calibrated with a Faraday cup or a calorimeter. It has been used extensively in an experiment at SLAC and has been found to be reproducible to the fractional percent level. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 718, 875, 1507, 1512, 1881, 1882, 1938, 2115, 2116, 2118, and 2121.

1751 (AD–671617) MEASUREMENTS OF THE NEUTRON ANGULAR FLUX SPECTRUM IN WATER. Annual Summary Report, October 1, 1966–September 30, 1967. Profio, A. E.; Cerbone, R. J.; Carriveau, G. W.; Gozani, T. (Gulf General Atomic, Inc., San Diego, Calif.). Nov. 20, 1967. Contract DA-49-146-XZ-482. 139p. (GA–8355; DASA–2056). CFSTI.

Measurements of the neutron angular flux spectrum from a near-fission point source in infinite water were made to provide a standard of comparison for neutron penetration calculations. The spectrum from 0.002 eV to 15 MeV was measured with a typical accuracy ±20% and a resolution of ±5% at angles from 0 to 90° and radii out to 38.1 cm. In addition, dieaway and foil traverse measurements were made. Measurements were compared with preliminary discrete-ordinates calculations with moderately good agreement in the fast neutron spectrum. Additional work is required to calculate the low-energy flux correctly. (auth) (USGRDR)

1752 (BNL–12226) SIZE-DEPENDENT EXTRAPOLATION DISTANCES FOR PULSED SMALL SYSTEMS. Dorning, J. (Brookhaven National Lab., Upton, N. Y.). Feb. 1968. 9p. (CONF-680601–36). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Size-dependent extrapolation distances were calculated for small spherical light water systems using the pulsed-neutron experiment asymptotic decay constant as a consistency criterion between exact transport theory and asymptotic reactor theory. The method used related a real system dimension to an extrapolated system dimension through the fundamental-mode time decay constant. The decay constants used were taken from previous work in which they were calculated as a function of system size by the S_n method. (D.C.W.)

1753 (CCDN-NW–1) NEWSLETTER NO. 1. (ENEA Neutron Data Compilation Centre, Gif-Sur-Yvette (France)). May 1966. 45p. Dep.

The activities and facilities of the Neutron Data Compilation Center (CCDN) are described. Instructions are given for the use of CCDN, and the services available are outlined. The Computer Index of Neutron Data (CINDA) and Sigma Center Information Storage and Retrieval System (SCISRS) projects are described. (J. W.R.)

1754 (CCDN-NW–2) NEWSLETTER NO. 2. (ENEA Neutron Data Compilation Centre, Gif-Sur-Yvette (France)). June 1966. 95p. Dep.

A listing of the references of all data held on the SCISRS (Sigma Center Information Storage and Retrieval System) master tape as of June 1966 is presented. The CINDA (Computer Index of Neutron Data) entries associated with the SCISRS entries are included. (J.W.R.)

1755 (CCDN-NW–5) NEWSLETTER NO. 5. (ENEA Neutron Data Compilation Centre, Gif-Sur-Yvette (France)). Apr. 1967. 56p. Dep.

A compilation of evaluations of neutron cross sections that were available from the CCDN (ENEA Neutron Data Compilation Center) as of April 1967 is presented. (J.W.R.)

1756 (EUR–4071) PHYSICAL THEORY OF THE DECAY OF A NEUTRON PULSE IN A FINITE MEDIUM. Rossi, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). July 2, 1968. 72p. (In Italian). Dep.

The problem of the time evolution of a neutron pulse in a finite moderator is discussed in the framework of the Boltzmann neutron transport equation. After a presentation of the mathematical and physical background, the experimental results and the recent theoretical contributions to their interpretation are reviewed. (auth)

1757 (INR-P–925) TIME BEHAVIOUR OF THERMAL NEUTRONS IN MODERATING MEDIA. Borysiewicz, M.; Mika, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 27p. Dep.

The properties of neutron scattering kernels in various moderators which influence the eigenvalue spectrum of the operator appearing in the Boltzmann equation describing the time behavior of thermal neutrons are investigated. It is shown that the corresponding scattering operators are compact in all cases except for the elastic scattering in solids, which leads to a bounded operator. These effects allow description of the structure of the spectrum of the Boltzmann operator and permit proof of the existence and uniqueness of the solution of the initial value problem. (auth)

1758 (N–68–30001) FISSION NEUTRON ATTENUATION IN ^{6}Li, NATURAL LITHIUM HYDRIDE, AND TUNGSTEN. Lahti, Gerald P. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1968. 24p. (NASA-TN-D–4684). CFSTI.

A fission-spectrum neutron-dose-rate-attenuation curve was computed by the discrete-ordinates method for Li^{6}H and natural LiH for penetration depths up to 139.5 cm. Results were compared with a recent Monte Carlo calculation for natural LiH. A single value for an energy-independent-neutron-removal cross section for ^{6}Li and natural Li in LiH was deduced for use in an Albert–Welton dose-attenuation kernel but is accurate for only a given range of penetration. The validity of fast-neutron-removal theory was demonstrated for the cases of W followed by LiH. From this penetration data, a neutron-removal cross section for W was calculated. (STAR) (auth)

1759 (RD/B/N–1042) ASYGAD AND GADUP: PROGRAMS FOR STUDYING THE DEPLETION BEHAVIOUR OF SELF-SHIELDED BODIES OF GADOLINIA. Clarke, R. H. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Sept. 1968. 44p. Dep. UK.

The codes ASYGAD and GADUP were programmed for the IBM 360/75 computer to perform the depletion calculation of self-shielded bodies of gadolinia in asymmetric neutron flux distributions. GADUP coded in CEGB Usercode, treats infinitely long bodies of any geometrical cross section which are lightly self-shielded, while ASYGAD, which is written in FORTRAN IV, treats highly self-shielded infinite cylinders. The programs were used to study the depletion of a variety of poison shapes, densities, and sizes varying from a few to 40 or 50 mean free path diameters. Results are presented for the absorptive worth of the poisons, and also for the flux shapes and number density distributions through them. (auth) UK)

1760 (Y-DR–1) THERMAL NEUTRON FLUX DISTRIBUTION FROM A ^{252}Cf SPONTANEOUS-FISSION NEUTRON SOURCE. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Oct. 17, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

Measurements were made of the spatial distribution of the thermal neutron flux near a ^{252}Cf spontaneous-fission neutron source in water. A maximum value of 0.0132 thermal neutrons/cm^2 per source neutron was found near the source and the distribution was in excellent agreement with fluxes previously calculated using the ANISN code. The californium was dispersed in aluminum and sealed in an aluminum cylinder, 0.364 in. o.d. and 0.75 in. long. The source strength was determined to be $7.32 \pm 0.36 \times 10^8$ neutrons/sec. (auth)

1761 THE KINETIC Sn APPROXIMATION OF NEUTRON TRANSPORT. Pavelescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 17: 941-9(1965). (In Rumanian).

During the startup and the shutdown of a reactor and during changes of the power level, the number of neutrons produced in the fission process does not remain equal. In view of the time-dependent nature of the neutron flux, the transient flux must be known in order to control the system. The S_n approximation of the Boltzmann neutron transport equation was found to express satisfactorily the complex transient processes. A solution was derived for the kinetic S_n approximation on the basis of previous studies of the stationary situation; the equations obtained may be used to determine the flux distribution, applying the same boundary conditions as in the stationary case. Choice of the time interval t and distance s is important, as the flux must remain a linear function of t and s. (TTT)

1762 NON-1/v THERMALIZATION PARAMETERS IN WATER. Bansal, N. K.; Goyal, I. C.; Ghatak, A. K. (Indian Inst. of Tech., New Delhi). J. Nucl. Energ, 22: 517-24(Sept. 1968).

The non-1/v thermalization parameters for water were calculated by the use of realistic scattering models. Cadmium, gadolinium, and samarium were used as typical non-1/v absorbers. A detailed study of the time-dependent spectra was made, and re-

sults were obtained as a function of waiting time. The calculated values are compared with the available experimental data. (auth) (UK)

1763 A NEW APPROACH TO ENERGY-DEPENDENT NEUTRON TRANSPORT THEORY. Williams, M. M. R. (London Univ.). J. Nucl. Energy, 22: 535-46(Sept. 1968).

A new approach to energy-dependent neutron transport theory is described which treats the asymptotic solution of the Boltzmann equation exactly and approximates the spatial transient by the separable kernel model. The method is illustrated by an application to the Milne and pulsed neutron problems, and exact expressions are obtained for the extrapolated endpoint and the emergent angular distribution. It is pointed out that the method can be extended to include criticality problems and three-dimensional geometries. (auth) (UK)

1764 TRANSIENT SPECTRA IN BERYLLIUM OXIDE. Tewari, S. P.; Trikha, S. K. (Univ. of Delhi). J. Nucl. Energy, 22: 569-77(Sept. 1968).

By means of the Placzek kernel with $\theta_D = 855°K$, the transient spectra in various beryllium oxide assemblies following a pulse of fast neutrons were studied. The time-dependent neutron density is expanded in terms of the eigenfunctions of the time-independent Boltzmann operator. The eigenvalues and the corresponding eigenfunctions were obtained by the diagonalization of the symmetrized kernel matrix. The lowest eigenvalue so obtained corresponds to the asymptotic decay constant, and is compared with the experimental results. A fairly good agreement between the two sets of values is obtained. The slowing down relaxation time, τ_{th}, in various assemblies is calculated at times $t > 700$ μsec. For $B^2 = 0.01$ cm^{-2}, $\tau_{th} = 202$ μsec is obtained, which agrees well with the experimental result of Zhezherun et al. (1964). (auth) (UK)

1765 NEUTRON PROPAGATION IN URANIUM DIOXIDE. PART II. DOPPLER EFFECT IN ^{238}U. Abagyan, L. P.; Golubev, V. I.; Golyaev, N. D.; Zvonarev, A. V.; Koleganov, Yu. F.; Nikolaev, M. N.; Orlov, M. Yu. At. Energ. (USSR), 25: 297-302(1968). (In Russian).

The influence of the Doppler effect on the ^{238}U (n,γ) reaction velocity in a small hot U_3O_8 sample was investigated through the neutron spectrum in the dioxide reflector of BR-I reactor. The measurements were made in the interval of temperatures from 300 to 2000°K. Direct proportionality exists between the velocity increment and $(\sqrt{T_h} - \sqrt{T_c})$ (T_h is the hot sample temperature and T_c is the temperature of the medium and the cold sample in °K). The measurements were compared with calculations. Results of the comparison prove the accuracy of the ^{238}U cross-section calculation method for the hot sample. (auth)

1766 EXPERIMENTAL EVALUATION OF MINIMA IN THE TOTAL NEUTRON CROSS SECTIONS OF SEVERAL SHIELDING MATERIALS. Straker, E. A. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 34: 114-21(Nov. 1968).

Neutron total cross sections in the energy range from 1 to 11 MeV were experimentally evaluated for several shielding materials by comparing calculations and measurements of the spectra of the uncollided flux transmitted through thick samples. This technique provides a critical test of the minima in the cross sections but yields little information about the resonance regions. Special emphasis has been placed on evaluating the total cross sections in the Evaluated Nuclear Data File (ENDF/B), which, in most cases, are the best available, the exceptions being for iron and tungsten. (auth)

1767 THERMAL-NEUTRON FLUX GENERATION BY HIGH-ENERGY PROTONS. Coleman, W. A. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.); Alsmiller, R. G. Jr. Nucl. Sci. Eng., 34: 104-13(Nov. 1968).

Calculations are presented of the thermal-neutron flux as a function of position in a water moderator surrounding a variety of thick targets which are bombarded by protons in the energy range 540 to 2000 MeV. The calculated results are compared with experimental values, and very good agreement is obtained. Results are also given for the thermal-neutron flux as a function of position in a D_2O moderator and for the energy deposition in the targets and the moderators. (auth)

1768 NULL-MATRIX ALLOY FOR NEUTRON DIFFRACTION. Smith, J. H. (Monash Univ., Victoria, Australia); Vance, E. R.; Wheeler, D. A. J. Phys., E (London), 1: 945-6(Sept. 1968).

For thermal neutrons, the coherent scattering cross section is close to zero for a gamma-phase manganese copper alloy containing 68 atomic % manganese. The alloy is easily manufactured, worked, and soldered, and could have a practical application as a material for the construction of neutron windows and specimen containers in neutron diffraction apparatus. Some properties of the alloy are compared with those of other window materials. (auth) (UK)

1769 INTERPRETATION OF THE NUMERICAL SOLUTION OF THE NEUTRON PULSED SOURCE PROBLEM. Wood, J. (London Univ.). J. Nucl. Energy, 22: 525-34(Sept. 1968).

The "pulsed source" problem, in the diffusion approximation, is solved numerically using two scattering models for Be: a simple one-term degenerate kernel, and a multiphonon kernel with Bhandari's $\sigma_{tr}(E)$. The results are compared with Corngold and Durgun's analytic solution for the simple kernel. It is found that the form of the numerical eigenvalue spectra for the two models is very similar. When $B^2 > B^{*2}$, the numerical eigenvalues, with their amplitudes, combine to predict a pseudo-exponential decay rate in good agreement with Corngold and Durgun's p_0 parameter, for the simple kernel. For the more realistic kernel, with large B^2, the departure from true exponential decay is also found to be small (less than 10% between 1 and 2 msec after the pulse at 21°C). (auth) (UK)

1770 SPACE-DEPENDENT EFFECTS IN ROSSI-ALPHA EXPERIMENTS. Iijima, Tsutomu; Sugi, Teruo; Ezure, Hideo; Kasai, Mineo (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 33: 344-8(1968).

Experiments were performed with a light water-moderated natural-uranium subcritical assembly in an attempt to confirm the space-dependent theory of Rossi-α experiments and to investigate experimentally the space dependence. The validity of the theory was confirmed by the measurements. (D.C.W.)

1771 CALCULATION OF THE NEUTRON DISTRIBUTION IN THE VVR-S REACTOR BY THE S_n APPROXIMATION. Pavelescu, M.; Rosescu, T. (Institutul de Fizica Atomica, Bucharest). Stud. Cercet. Fiz., 17: 997-1015(1965). (In Rumanian).

The S_n approximation is the most important method for solving the Boltzmann equation. It may be used to obtain a solution for various geometries, using the multigroup theory on a large-memory computer. Details of the program, used for actually solving a problem at the Institute of Atomic Physics, are indicated in detail, considering a cylindrical geometry and an isotropic source. The method was programmed for a CIFA-101 computer, using repeated iterations for determining the neutron source. The calculation was stopped when, after a number of operations, the difference between values becomes sufficiently small. In the case described, a 3% difference required 10 iterations. The 2 families of curves obtained agree with values derived from two-group calculations of the simple diffusion approximation. (TTT)

1772 DISCUSSION OF THE QUASIELASTIC SCATTERING OF NEUTRONS IN INCOHERENT LIQUIDS. Purohit, S. N. (Aktiebolaget Atomenergi, Studsvik, Sweden). Phys. Chem. Liquids, 1: 13-32(Feb. 1968).

A critical discussion of the quasi-elastic scattering of neutrons by incoherent (hydrogenous) liquids is presented. A general formalism for studying the incoherent scattering of neutrons is outlined. The scattering law $S(K,\omega)$ is expressed in terms of a generalized diffusion coefficient $D(K,\omega)$ which is related to the response function corresponding to the fluctuations in the local density. This representation may be useful for a comparative study of several phenomenological models employed in the analysis of the quasi-elastic scattering of neutrons. Three types of phenomenological models are discussed: the diffusion model in the form applied by Vineyard; the jump diffusion model of Singwi and Sjölander, of which a variation is discussed as well as a formulation of a stochastic model using the Langevin equation of motion to describe the damped harmonic vibrations and also diffusive modes; and the single relaxation time models. Ruijgrok as well as Kadanoff and Martin modified the simple diffusion model so as to take into account the reversible character of the dynamic motion by introducing a single relaxation time. A single relaxation time can be introduced to simplify the collision integral in the linearized Boltzmann equation. An extension is presented of the Singwi–Sjölander expression for $S(K,\omega)$, so as to include the contribution of one phonon term explicitly, previously only the zero phonon term was treated. A qualitative discussion of the temperature-dependent quasi-elastic scattering results is offered in terms of the diffusion cooling phenomenon on a microscopic scale. (BBB)

1773 VARIABLE INTENSITY NEUTRON GENERATOR COMPRISING INTERMESHING WEBS OF BERYLLIUM FOIL AND RADIUM IMPREGNATED GOLD FOIL. Holm, Warren M. (to Radium Chemical Co., Inc.). U. S. Patent 3,400,269. Sept. 3, 1968. Filed Mar. 17, 1965.

A variable-intensity neutron generator is described in which helically wound intermeshing webs of Be foil and Ra-bearing Au foil are used. One of the helical webs is stationary, while the other web is connected to an armature that registers with the axial bore

of a solenoid and spring urged outwardly to drive the helical webs into maximum registry. The neutron intensity is adjusted by controlling the current to the solenoid and hence the degree of registry of the webs. (D.C.W.)

1774 GENERATING FUNCTIONS FOR THE EXACT SOLUTION OF THE TRANSPORT EQUATION. I. Abu-Shumays, I. K.; Bareiss, E. H. (Argonne National Lab., Ill.). J. Math. Phys. (N. Y.), 9: 1722-31(Oct. 1968).

Generating functions are used as analytic tools for the transformation of the integro-differential transport equations to partial differential equations. The transformations are constructed so that their inverses are known. Therefore, the problem of solving the integro-differential equations is reduced to the more familiar problem of solving partial differential equations. The general method is described in detail for slab geometry. The general solution is given in analytic form, and the one-to-one correspondence with Case's method of elementary solutions is demonstrated. The results are extended to slab geometry without axial symmetry. (auth)

1775 SOLUTIONS OF THE TWO-GROUP TRANSPORT EQUATION IN PLANE GEOMETRY. Metcalf, Dale Robert. Ann Arbor, Mich., Univ. of Michigan, 1968. 141p.

Thesis.

Exact solutions to the two-group neutron transport equation are obtained utilizing the singular eigenfunction approach. By this method exact solutions to a limited set of problems can be obtained against which the accuracy of conventional approximations may be tested. A detailed study was made of the singular eigenfunctions of the two-group transport equation. A convenient linear combination of the continuum eigenfunctions was selected to simplify later analysis. Using these eigenfunctions, a full-range completeness proof for infinite medium applications is presented. For the half-range case, reliance is placed on a half-range theorem proved several years ago and (with this as authority) the general half-range problem is rederived in a form convenient for numerical analysis. Explicitly, two coupled equations are obtained where the unknowns are the discrete and one continuum mode expansion coefficients. Finally, the remaining continuum mode expansion coefficient is expressed directly in terms of the other two coefficients. This general result is then applied to the solution of two typical half-space problems, the Milne and constant source problems. For comparison purposes the solutions of the two-group Milne and constant source problems are also obtained in the P_1, P_3, and DP_1 approximations. Special numerical methods developed for the computer solution to the exact problem are discussed in detail. Of particular importance is the development of a relatively fast and accurate method for calculating singular integrals. Computer codes are written in the Michigan Algorithm Decoder (MAD) language and a complete listing is given. With these codes anyone can (with different cross section sets) test the accuracy of conventional approximation methods. Calculations are performed for four light water systems with varying amounts of absorption. These calculations show that although the P_1 approximation yields fairly good results for the total flux and current, the angular distribution is not so well represented especially at the interface. The P_3 approximation continues to give negative inward angular fluxes but of a reduced magnitude. The DP_1 method improves significantly on the P_1 and P_3 angular fluxes as well as on the total flux and current. The boundary condition at the vacuum-medium interface can be specified exactly in the DP_1 approximation; therefore, the exit angular distribution at the boundary is well represented. An interesting result from this study was in the constant source case the exit angular distribution becomes less pronounced in the forward direction with increased absorption in the medium. This is in contrast to the Milne problem where the opposite effect is noted. Also of interest is the fact that the P_1 approximation in two-group theory yields two eigenvalues in the continuum (as well as two outside the continuum) while in the one-group case both eigenvalues are outside the continuum. This means that in two-group theory more than just the asymptotic solution is obtained even in the lowest order approximation. In two-group neutron transport theory, the P_3 and DP_1 approximations present essentially the same computational difficulty. It is concluded that in reactor physics design analysis (with reactor parameters similar to those studied here) the DP_1 approximation is much to be preferred over the P_3. (Disser. Abstr.)

1776 QUASI-ELASTIC SCATTERING OF COLD NEUTRONS IN $C_3H_5(OD)_3$ AT VARIOUS TEMPERATURES. Rapeanu, S. (Inst. for Atomic Physics, Bucharest). Phys. Lett., 28A: 31-2 (Oct. 21, 1968).

The quasi-elastic scattering of cold neutrons in partially deuterated glycerine was investigated by means of a time-of-flight spectrometer. The line widths were derived and fitted to Larsson's model. (auth)

1777 EFFECTIVE FLUX AND EFFECTIVE CROSS SECTION FOR THE (n,γ)-REACTION IN THE SPECTRUM OF REACTOR NEUTRONS. Romanov, Yu. F. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 10, 150-2(May 1968). (In Russian).

The concept of the effective cross section for reactor neutron spectra is introduced. The effective cross section is determined through the cadmium ratio and the corresponding thermal cross sections and resonance integrals. (J.W.R.)

1778 STOCHASTIC FORMULATION AND INTERPRETATION OF NEUTRON TRANSPORT EQUATIONS. Yang, Chio-min. University Park, Pa., Pennsylvania State Univ., 1967. 113p.

Thesis.

The two lowest-order equations in the hierachy of statistical relations descriptive of neutron transport are considered via intuitive stochastic arguments. Concepts such as singlet and doublet particle densities and their relations to the mean and variance of a neutron population are developed. The Green's function, in the stochastic sense, is defined and the effects on the density of neutrons at a phase point and time due to various kinds of interactions at another phase point and earlier time are deduced. Two relations describing neutron probability balance are constructed—dealing with a single phase element, the other dealing with two separate ones. By using these relations and the basic concepts developed, the singlet and doublet density equations of neutron transport are derived. The doublet density equation of neutron transport derived by the stochastic method of this work contains two phase points and two arbitrary times as independent variables as compared to the doublet density equation derived by Osborn and Yip which has a single time for both phase points. That their equation is a special case of the result of this work is shown by setting the two times equal. The correlation function involving two times synthesized by Akcasu and Osborn via the Langevin technique is deduced from the doublet density equation of this work by writing the Green's functions in their operator forms. A formal solution for the doublet density equation is found. The formal solution contains Green's functions, the singlet density, and the various parameters of the system. Some examples of simple systems with known Green's functions are considered in detail and their doublet density, correlation function and system variance-to-mean ratio are calculated. The solution of the one-time doublet density equation constructed by Otsuka and Saito is deduced as a special case of the formal solution of the doublet density equation. A one-speed, isotropic approximation of the formal solution is shown to be of the same form as the basic assumption used by Sheff and Albrecht in their work on space analysis of reactor noise. Registrations of neutron counting are regarded as fictitious stationary particles. Their singlet and doublet densities are defined. Equations governing behaviors of these counting particles are presented. (Diss. Abstr.)

1779 USE OF SYMMETRY AND OTHER FEATURES OF NEUTRON TRAJECTORIES IN ORDER TO EXPEDITE MONTE CARLO CALCULATIONS. Dyad'kin, I. G.; Starikov, V. N. Zh. Vychisl. Mat. i Mat. Fiz., 8: 1001-12(Sept.-Oct. 1968). (In Russian).

An algorithm was developed for selecting neutron trajectories after scattering in various media, including collisions with various nuclei in which the directions of approach before scattering are different. In order to obtain accurate probabilities for neutron migration at large distances, it is proposed that a high degree of symmetry be used between different trajectory sections. Applications to well logging are discussed. (R.V.J.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 1809, 1882, and 1929.

1780 NEUTRON POLARIZATION FROM THE REACTION $^3H(d,n)^4He$ AT 70°(LAB.) AT DEUTERON ENERGIES BELOW 2 MeV. Hentschel, G.; Mack, Guenther; Mertens, G. (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1401-8(Sept. 1968).

The neutron polarization in the reaction $^3H(d,n)^4He$ was determined at deuteron energies of 0.3 to 1.9 MeV by measuring the asymmetry in neutron scattering by ^4He. The time-of-flight method was used, and the polarization values were calculated from the asymmetries by the Monte Carlo method. (D.C.W.)

1781 REACTION $^4He(\gamma,p)T$. Mundhenke, R.; Kosiek, R.; Kraft, G. (Univ., Heidelberg). Z. Phys., 216: 232-40(1968). (In German).

The energy spectrum of photoprotons from ^{4}He was investigated with 28- and 32.5-MeV bremsstrahlung using a CsI(Tl) spectrometer and a Si counter. The (γ,p) cross section was derived for excitation energies from 23 to 32 MeV. (auth)

1782 THE ELASTIC SCATTERING OF ^{3}He FROM TRITIUM AND ^{3}He. Bacher, A. D.; Spiger, R. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). Nucl. Phys., A119: 481-96 (1968).

The cross sections for the elastic scattering of ^{3}He from tritium and ^{3}He were measured for bombarding energies from 4.3 to 21.4 MeV and from 11.9 to 18.9, respectively. The results agree well with a recent resonating-group calculation in which the marked change in the shape of the angular distributions above 15 MeV is attributed to a broad resonance in the $l = 3$ partial wave. (auth)

1783 PHOTOPRODUCTION OF π^0 MESONS FROM ^{3}He WITH 340-MeV BREMSSTRAHLUNG. Blecher, Marvin. Urbana, Ill., Univ. of Illinois, 1968. 116p.

Thesis.

Cross sections for the coherent photoproduction of π^0 mesons from ^{3}He ($\gamma + {}^3\text{He} \rightarrow \pi^0 + {}^3\text{He}$) were measured for recoil angles of 20, 30, 40, and 50° from the direction of the incident photon. A gaseous ^{3}He target was irradiated by 340-MeV bremsstrahlung. The ^{3}He gas was maintained at liquid hydrogen temperature and at a pressure of slightly above one atmosphere. The recoil nuclei were observed with Si semiconductor detectors. At least one gamma ray from the pion decay was detected with a lead glass Cherenkov counter. A coincidence between a semiconductor detector and the Cherenkov counter triggered an oscilloscope on which all pulses were then displayed and photographed. These photographs constitute the experimental data. The cross sections at 20° ranged from 2 to 8 μb, at 30° from 5 to 25 μb, at 40° from 16 to 56 μb, and at 50° from 17 to 84 μb. The experimental results were compared with those predicted by an impulse approximation calculation. When neglecting final-state interactions and many-body forces, the cross section is directly proportional to the square of the nuclear matter form factor. The form factor used is that obtained from electron scattering experiments. The form factor reduces the cross sections from the values you would expect for an equivalent number of nucleons and thus gives information about the structure of the nucleus. The theory also depends upon the amplitudes for the photoproduction of neutral pions from free nucleons. These amplitudes are strongly dependent on the nucleon kinematics since the $\gamma + n \rightarrow \pi^0 + n$ cross section goes through a very sharp resonance around 320 MeV. In this experiment the kinematics for system $\gamma + {}^3\text{He} \rightarrow \pi^0 + {}^3\text{He}$ are well defined, however, there is no correct method for choosing the nucleon kinematics. Thus, for different methods of calculating the nucleon kinematics we obtain widely varying results; indicating a more sophisticated theory is needed. (Disser. Abstr.)

1784 FINAL STATE INTERACTIONS IN THE REACTIONS ^{3}He(^{3}He,2p)^{4}He AND T(^{3}He,np)^{4}He. Blackmore, Ewart William Allan. Vancouver, B. C., Univ. of British Columbia, 1967.

Thesis.

Final-state interactions in the p-p and p-n systems corresponding to the formation of the singlet states of the di-proton and the deuteron were observed in the reactions ^{3}He(^{3}He,2p)^{4}He and T(^{3}He,np)^{4}He, by measuring the energy spectra of two of the final-state particles detected in coincidence. These interactions appear as regions of high density of events along the kinematic contours in two-dimensional energy space. Both p-p and p-^{4}He coincidences from the reaction ^{3}He(^{3}He,2p)^{4}He and p-^{4}He coincidences from the reaction T(^{3}He,np)^{4}He were studied. The dominant mechanism producing the three-particle final states was found to be the sequential breakup through the states of ^{5}Li and ^{5}He, in agreement with the results of previous experiments. The interaction between the two nucleons affects the distribution of coincidence events only in the region of two dimensional energy space corresponding to a breakup in which the two nucleons emerge with low relative energy. The relative contributions of the different processes in the reaction ^{3}He(^{3}He,2p)^{4}He was determined for incident ^{3}He energies from 1.15 MeV to 5.0 MeV. It was found that the nucleon-nucleon interaction becomes less important as the incident energy increases. The validity of two approximate theories of final state interactions, the Watson theory and the Phillips, Griffy and Biedenharn density of states formalism, was checked by comparing their predictions with the observed energy spectra. (Disser. Abstr.)

1785 STUDY OF THE ^{3}He(p,d)2p FINAL-STATE INTERACTION AT 30.2 AND 46.0 MeV. Chang, Chia-cheh. Los Angeles, Univ. of Southern Calif., 1968. 103p.

Thesis.

The ^{3}He(p,d)2p reaction was studied at proton energies of 30.2 and 46.0 MeV. The ^{3}He gas (nominal purity was 99.98%) was contained in a small gas cell which was placed inside a large vacuum chamber. The emerging deuterons were detected with a ΔE-E counter telescope in conjunction with a two-dimensional pulse height analyzer. Deuteron energy spectra at eight different angles in the range 10 to 40° (lab) for $E_p = 30.2$ MeV, and twelve different angles in the range 13 to 50° (lab) for $E_p = 46.0$ MeV were obtained. The results showed that at both energies the peaking near the high-energy cut-off, interpreted as due to the final-state p-p interaction, decreased very rapidly as the angle of observation was increased; it reached a minimum at about 22.5° (lab) and a second maximum at about 35° (lab). The angular distributions attributed to the final-state interaction were obtained by integrating the deuteron energy spectra between the limits corresponding to a relative p-p energy of 0 to 4 MeV. (It was found that the shape of the angular distribution did not vary significantly if a relative p-p energy of 0 to 8 MeV was taken.) The results showed diffraction patterns which seem to imply a direct nuclear reaction mechanism. Different theoretical approaches were employed to interpret the experimental results. First of all, the Watson-Migdal formulism (short-range reaction mechanism) was used to fit the deuteron energy spectra near the high energy cut-off. It was found that with a p-p scattering length of a = −7.8 F, the calculated results predicted a peak which was too broad. This may be due to the fact that the deuteron has an extended structure. Second, the impulse approximation was used to fit the deuteron energy spectra. Two different ^{3}He wave functions were investigated: A Gaussian and a Yukawa wave function. Of the two variable parameters, the p-p scattering length "a" was kept fixed at a = −7.8 F. The corresponding α's resulting in best fit to the experimental data, seemed reasonable and gave a reasonable rms radius of ^{3}He. It was found that both wave functions gave very similar fits to the experimental data. From the shape of the angular distributions, it was expected that the pick-up mechanism would play an important part in the primary production process. This was also borne out by the results of plane-wave and DWBA calculations carried out for both incident proton energies. The calculations, using the function $[j_0(qR)]^2$ predicted the positions of the maxima and the minima only, while DWBA calculations reproduced quite well the experimental angular distributions. In view of the above, it can be concluded that the strong peaking at the high energy cut-off of the deuteron energy spectra at small angles is predominantly due to the effect of the p-p final-state interaction and that the shape of the spectra can be reproduced using an impulse approximation calculation, and that a pick-up mechanism plays an important part in the reaction as is evidenced by the angular distribution of the deuteron energy spectra evaluated in the neighborhood of the high energy cut-off. (Disser. Abstr.)

1786 EXPERIMENTAL STUDY ON LOW-ENERGY LEVELS OF ^{4}He. Manduchi, C.; Moschini, G.; Tornielli, G.; Zannoni, G. (Univ., Padua). Nuovo Cim., 57B: 340-50(Oct. 11, 1968).

The elastic scattering of protons from tritium was measured at a few selected proton energies between 3.11 and 4.60 MeV. A phase-shift analysis based on these scattering data and previous polarization data for the reaction ^{3}H(p,p)^{3}H was made for proton energies 3.16, 3.86, and 4.53 MeV. (auth)

1787 CROSS SECTION AND POLARIZATION IN THE PHOTODISINTEGRATION OF THE DEUTERON. Zernik, Wolfgang. New Haven, Yale Univ., 1959. 94p.

Thesis.

Current forms of the semi-phenomenological two-nucleon potential are discussed briefly with special attention to the improvements made at Yale. The interaction of the deuteron with the electromagnetic field is derived using elementary methods and the shortcomings of this approach pointed out. It is shown how amplitudes for the D(γ,n)p reaction may be calculated and used to obtain the differential cross section and the polarization of the outgoing particles. It is also shown how the method may be extended to deal with tensor coupling in the final states. The theory is developed for both plane and elliptically polarized gamma rays. Numerical results are given in five successive approximations in order to exhibit the effects of the various multipole transitions. The calculations are carried out for two potentials, one having a spin-orbit force in the triplet odd states only and the other having a spin-orbit force in the triplet even states as well. The potential used is described in detail. The relations that hold between the results for neutrons and those for protons are pointed out. The feasibility of calculations employing phase shifts only to describe the continuum states is discussed briefly. The theoretical results for the differential cross section are compared with experimental values and it is concluded that while really quantitative agreement has not yet been achieved the results are at least not inconsistent with the assumption that the static interaction represents the data to a good degree of approximation for gamma-ray energies up to 30 MeV and possibly even at higher energies. The theoretical significance of polarization measurements is discussed. (Diss. Abstr.)

1788 PROTONS FROM THE DISINTEGRATION OF DEUTERONS BY 8- TO 28-MeV NEUTRONS. Bond, A. (Univ. of Wisconsin, Madison). Nucl. Phys., A120: 183-92(1968).

Proton spectra from the ^{2}H(n,p)2n reaction were measured for neutron bombarding energies of about 8, 10, 13, 14, 23, and 28 MeV at an average proton emission angle of 5° and for bombarding energies of 10 and 28 MeV at an angle of 20°. Measurements were performed with a counter telescope. Absolute cross sections were obtained by comparing breakup yields with those from elastic n-p scattering. The 5° data are compared with the predictions of the Watson theory and the impulse approximation. At 23 and 28 MeV, the Watson theory yielded peaks near the maximum break-up energy which were much broader than those measured. The impulse approximation yielded fits at all bombarding energies with values of the n-n scattering length ranging from 13.5 to 22 fm. (auth)

1789 ELASTIC ELECTRON SCATTERING FROM ^{4}He. Malecki, A.; Picchi, P. (CNEN, Frascati, Italy). Phys. Rev. Lett., 21: 1395-8(Nov. 4, 1968).

The influence of dynamical nucleon-nucleon correlations on elastic electron scattering from light nuclei is discussed. The numerical results for ^{4}He are presented. (auth)

1790 POLARIZATION IN THE ELASTIC SCATTERING OF 22.7-MeV PROTONS FROM DEUTERONS. Garreta, D.; Papineau, A.; Sura, J.; Tarrats, A. (CEN, Saclay, France). Phys. Rev. Lett., 21: 1393-5(Nov. 4, 1968).

The polarization in nucleon-deuteron elastic scattering was measured at a laboratory energy of 22.7 MeV. The angular range of detection was 19.5 to 143.6° and 68 to 154° in the center-of-mass system for the scattered protons and recoil deuterons, respectively. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 1767, 1826, 1827, 1832, 1878, 1881, 1882, 1929, and 1955.

1791 (AD-669924) ^{16}O(α,2α)^{12}C(g.s.) REACTION MECHANISMS NEAR 25 MeV. Parker, A. W.; Allen, J. A.; Yerke, R. L.; Stotland, V. G. (Illinois Univ., Urbana. Dept. of Physics). May 1968. Contract N00013-67-A-0305. 58p. CFSTI.

Measurements of the angular correlation between the two alpha particles emitted in the reaction ^{16}O(α,2α)^{12}C(g.s.) at incident energies near 25 MeV suggest that this reaction can be described in terms of both sequential and one-step knockout processes. The sequential reaction proceeds as inelastic alpha-particle scattering followed by alpha-particle decay of the excited levels of ^{16}O to levels of ^{12}C. Only the transitions to the ground state of ^{12}C were studied. The most strongly excited levels were those at 11.1 and 13.88 MeV. The strong energy dependence of the cross section for the reaction going through the 13.88-MeV level indicates the existence of a broad state in ^{20}Ne with an excitation energy near 24 MeV. Apparently, resonance effects are present in the initial-state interaction at this excitation. Any quasielastic scattering appears as a background under the peaks of the sequential reaction. The angular distribution of this background is in limited agreement with the predictions of a modified Born approximation model which takes into account the final-state interaction between the two alpha particles. (auth) (USGRDR)

1792 (COO-1265-57) THE T = 2 MULTIPLET IN NUCLEI OF MASS 10. Harrison, William D. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Jan. 1968. Contract AT(11-1)-1265. 7p. Dep. CFSTI.

It is suggested that structure in the ^{7}Li(^{3}He,p')^{9}Be* cross section may be due to a T = 2 state in ^{10}B at about 23.0 MeV excitation energy with a width of roughly 0.5 MeV. The corresponding mass of the unobserved nucleus ^{10}Li is estimated. (auth)

1793 FORMATION CROSS SECTIONS OF VARIOUS RADIONUCLIDES FROM Ni, Fe, Si, Mg, O, AND C FOR PROTONS OF ENERGIES BETWEEN 0.5 AND 2.9 GeV. Rayudu Garimella, V. S. (Carnegie Inst. of Tech., Pittsburgh). Contract AT(30-1)-844. J. Inorg. Nucl. Chem., 30: 2311-15(Sept. 1968).

Formation cross sections of ^{56}Co, ^{54}Mn, ^{52}Mn, ^{51}Cr, ^{48}Cr, ^{48}V, ^{47}Sc, ^{44m}Sc, ^{32}P, ^{24}Na, and ^{7}Be from Fe; ^{56}Co, ^{54}Mn, ^{51}Cr, ^{48}V, ^{32}P, ^{24}Na and ^{7}Be from Ni; ^{24}Na, ^{22}Na and ^{7}Be from Si and Mg; and ^{7}Be from C and O were measured for incident protons of energies 0.5, 0.8, 1.5, 2.2, and 2.9 GeV. The trends in measured cross sections are discussed. Some qualitative conclusions are drawn about the production of cosmogenic activities in meteorites. (auth) (UK)

1794 CROSS SECTION FOR THE ^{16}O(n,α)^{13}C REACTION. Parnell, C. J. (Hammersmith Hospital, London); Dandy, D.; Wankling, J. L. Phys. Med. Biol., 13: 665-6(Oct. 1968).

An understanding of the interactions of fast neutrons with the elements comprising soft tissue is of interest in connection with the possible use of fast neutrons in radiotherapy, and is necessary for dosimetric purposes; it may also assist in the interpretation of biological effects. The production of α particles from oxygen is particularly interesting in this respect. The cross section for the above reaction was measured in the energy range 8 to 12 MeV for the first time. Data are tabulated. (UK)

1795 STUDY OF MONOPOLE TRANSITIONS IN ^{12}C, ^{24}Mg, ^{28}Si, ^{32}S, AND ^{40}Ca BY INELASTIC ELECTRON SCATTERING. Strehl, P.; Schucan, Th. H. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 27B: 641-3(Oct. 14, 1968).

Transitions from the 0^+ ground states to 0^+ excited states at 7.66(^{12}C), 6.44(^{24}Mg), 4.98 and 6.69(^{28}Si), 3.78(^{32}S) and 3.35 MeV (^{40}Ca) studied with 30 to 60 MeV electrons at scattering angles from 105 to 165°. Matrix elements and transition radii were deduced, from DWBA calculations. The monopole excitations can be uniquely distinguished from E2 excitations by the different angular dependence of the cross sections. (auth)

1796 ADJUSTMENTS IN THE n-p SINGLET EFFECTIVE RANGE. Davis, J. C.; Barschall, H. H. (Univ. of Wisconsin, Madison). Phys. Lett., 27B: 636-7(Oct. 14, 1968).

Values of the n-p singlet effective range were recalculated from fast neutron total cross-section measurements, taking into account more accurate determinations of the neutron resonance energies below 5 MeV. (D.C.W.)

1797 THE 1p NEUTRON PICK-UP STRENGTHS IN THE REACTION ^{13}C(p,d)^{12}C. Taketani, H. (Tokyo Inst. of Tech.); Muto, J.; Yamaguchi, H.; Kikame, J. Phys. Lett., 27B: 625-7(Oct. 14, 1968).

Excited states up to about 18 MeV in ^{12}C were investigated with the ^{13}C(p,d)^{12}C reaction. It was found that five states (ground, 0^+, T = 0; 4.43 MeV, 2^+, T = 0; 12.71 MeV, 1^+, T = 0; 15.11 MeV, 1^+, T = 1 and 16.11 MeV, 2^+, T = 1) almost exhaust the available pick-up strength. Spectroscopic factors for these states extracted from a DWBA analysis with the usual separation energy procedure gave good agreement with the prediction of the effective interaction calculation by Cohen and Kurath. (auth)

1798 THE ^{13}C(d,n)^{14}N REACTION. Cookson, J. A. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Phys. Lett., 27B: 619-21(Oct. 14, 1968).

The ^{13}C(d,n)^{14}N reaction to the first three states of ^{14}N was measured between 7 and 12 MeV. The ratios of the spectroscopic factors extracted with normal DWBA were independent of beam energy in contrast with theoretical implications. (auth)

1799 ^{12}C WAVE FUNCTIONS. Boeker, E. (Vrije Univ., Amsterdam). Nucl. Phys., A119: 435-48(1968).

The ^{12}C ground state and its first excited 2^+ state at 4.43 MeV are described by angular momentum projection from the same Slater determinant in LS coupling. In contrast to Hartree-Fock (HF) calculations where the energy is minimized, the four parameters in the Slater determinant now are fitted to elastic and inelastic electron scattering form factors at momentum transfers $q < 1.62$ fm^{-1} for which Born approximation is used. The resulting Slater determinant gives different signs of the deformations in the two shells and results in a higher excitation energy of the 2^+ level than in usual HF calculations. At momentum transfers above the first diffraction minimum, the elastic form factor is reasonable, but the inelastic form factor is a factor of 8 too small. (auth)

1800 ATOMIC HYPERFINE STRUCTURE. I. POLARIZATION WAVE FUNCTIONS FOR THE GROUND STATES OF B, C, N, O, AND F. Schaefer III, Henry F.; Klemm, Richard A.; Harris, Frank E. (Stanford Univ., Calif.). Phys. Rev., 176: 49-58(Dec. 5, 1968).

In order to discuss atomic hyperfine-structure effects not exhibited by restricted Hartree–Fock wave functions, a "polarization wave function" is introduced. This wave function, designed to include core polarization, is defined to be that configuration-interaction function which includes the restricted Hartree–Fock function plus all symmetry-allowed configurations differing therefrom by one spatial orbital. Good approximations to polarization wave functions are reported here for the ground states of B, C, N, O, and F. The resulting magnetic hyperfine-structure parameters are in better agreement with experiment than in previous ab initio calculations, being subject to between 25 and 45% error in the spin-density contributions and to less than 2% error in the other terms. The value of $\langle r^{-3} \rangle$ is found to depend significantly upon the operator in which it appears, and this dependence causes us to conclude that

spin densities for B and C can not be deduced from available experimental data. The calculations are also used to provide improved values from the nuclear magnetic dipole moment of ^{11}C ($\pm 0.997\ \mu_N$) and for the nuclear electric quadrupole moments of ^{10}B(0.0804 b), ^{11}B(0.0386 b), ^{11}C($\pm$0.0322 b), and ^{17}O(–0.0256 b). (auth)

1801 PHOTOPROTON SPECTRUM FROM CARBON. Frederick, David E. (Ames Lab., Iowa). Nucl. Phys., A119: 347-55 (1968).

The 90° yield of protons was measured for the $^{12}C(\gamma,p)^{11}B$ reaction using bremmsstrahlung of 37.7-MeV endpoint energy. While moderate structure has previously been seen in $^{12}C(\gamma,n)^{11}C$ total cross-section measurements which summed over all states of ^{11}C, no significant structure is found with comparable energy resolution in the $^{12}C(\gamma,p_0)^{11}B$ reaction above 30 MeV. It is deduced that the $1s^{-1}1p_{\frac{1}{2}}$ hole-particle configuration is probably concentrated in either of the relatively strong levels at 31.5 ± 1.3 MeV and 35.7 ± 0.7 MeV excitation energy or is split between them. (auth)

1802 PICK-UP REACTIONS ON ^{11}B. Miljanic, D.; Furic, M.; Valkovic, V. (Inst. Ruder Boskovic, Zagreb). Nucl. Phys., A119: 379-84(1968).

The angular distribution of deuterons from the $^{11}B(n,d_0)^{10}Be$ reaction was measured at E_n = 14.4 MeV. The deduced spectroscopic factor is compared with those obtained from other reactions and with theoretical values. (auth)

1803 ELASTIC AND INELASTIC SCATTERING OF ^3He PARTICLES FROM ^{10}B AT 32 MeV. Squier, G. T. A. (Queen's Univ., Belfast); McClatchie, E. A.; Johnston, A. R.; Batten, R. J.; England, J. B. A.; Kingston, F. G. Nucl. Phys., A119: 369-78 (1968).

The differential cross sections for the elastic and inelastic scattering of 32.46-MeV ^3He particles from ^{10}B were measured. The elastic differential cross section was analyzed in terms of the optical model. The angular distributions for inelastic scattering to the 0.717-, 1.74-, 2.15-, 3.585-, 4.77-, and 6.03-MeV levels of ^{10}B were compared with the predictions of the collective model using DWBA analysis. (auth)

1804 TOTAL NEUTRON CROSS SECTIONS OF Be, C, AND F NEAR 14 MeV. Hunyadi, I. (Inst. of Nuclear Research, Debrecen, Hungary); Angeli, I. Nucl. Phys., A119: 525-8(1968).

Total neutron cross sections of Be, C, and F were measured by the transmission method in the energy range E_n = 13.70 to 14.60 MeV in steps of 50 keV. The accuracy of the relative total cross section data is better than 1%. The cross section curves suggest fluctuations for Be and F and a smooth variation for C. (auth)

1805 TOTAL REACTION CROSS SECTIONS FOR PROTONS BETWEEN 10 MeV AND 22 MeV ON ^{12}C AND ^{40}Ca. Dicello, John Francis Jr. College Station, Tex., Texas A and M Univ., 1968. 159p.

Thesis.

Total reaction cross sections for protons on ^{40}Ca were measured at fifteen energies between 10.3 and 21.6 MeV by the beam-attenuation method. The differential elastic cross sections for protons on ^{40}Ca were obtained at fifteen energies between 9.8 and 21.7 MeV. These measurements were made at intervals of 3° between 12 and 30° and at intervals of 5° between 35 and 165° in the laboratory. Total reaction cross sections for protons on carbon were measured at ten energies between 9.8 and 19.5 MeV. The total reaction cross section for ^{40}Ca rises sharply at low energies, reaches a maximum value around 13 MeV, and reaches a minimum around 16 MeV. The rise at the lower energies is a result of the Coulomb barrier. The dip at 16 MeV is probably associated with the (p,n) threshold at 16 MeV. The present differential elastic cross sections and total reaction cross sections for ^{40}Ca were compared with predictions of the optical model. The total reaction cross sections for carbon show resonant-like structures in the neighborhood of 10.4 MeV and 13.8 MeV. The structure observed in these total reaction cross sections is related to levels around 11.6 MeV and 14.6 MeV in the compound nucleus, ^{13}N. Because of the presence of these sharp resonances in the total reaction cross section, it does not seem reasonable to apply the optical model to ^{12}C at lower energies. (Disser. Abstr.)

1806 A STUDY OF NUCLEAR SHELL MODEL CALCULATIONS FOR THE FIRST p SHELL. Miller, Lanny Joe. Austin, Tex., Univ. of Texas, 1968. 129p.

Thesis.

A calculation of energy levels and magnetic moments of nuclei with A numbers 6, 7, 8, 12, 13, and 14 was made using a central interaction plus a spin-orbit interaction. A search for equivalent central interactions was also made. Detailed results are presented for the Rosenfeld interaction and are compared with the results of Barker and Kurath. (Disser. Abstr.)

1807 ELECTRON SCATTERING AND MUON CAPTURE IN A CONTINUUM MODEL. Friar, James Lewis. Stanford, Calif., Stanford Univ., 1968. 187p.

Thesis.

The giant resonance region of ^{12}C and ^{16}O was investigated using a continuum model, which is based on configuration mixing of negative-parity particle-hole states, with the particle in the continuum. Using this model T = 1, 1^- and 2^- electron scattering spectra were calculated as well as the 0^-, 1^-, and 2^- nuclear excitation spectra (or equivalently the neutrino spectra) in mu capture. The SU(4) relation $M_P^2 = M_V^2 = M_A^2$ was tested and found to be satisfied in both nuclei to better than 10 percent. In addition, the relation $(M_V^2) = (M_V^2)_{UD}\,|F_{el}-(\nu_{res}^2)|^2$ was tested and found to hold to within 3 percent. Both of these results justify the previous work of Foldy and Walecka on calculations of total muon capture rates. The detailed behavior of the electron scattering spectra was examined as a function of momentum transfer with emphasis on the magnetic contribution to the 1^- transverse electric spectra and the giant magnetic quadrupole resonances. The momentum dependence of integrated form factors for certain regions of the excitation spectra was also investigated. The results are compared with the existing electron scattering data, and predictions are made for the unexplored regions. Some results for T = 1, 3^- states in ^{12}C are also included as well as a discussion of $(1/M)^2$ corrections to the mu-capture interaction. (Disser. Abstr.)

1808 YIELD AND ANGULAR DISTRIBUTIONS IN THE ^{16}O ($^6Li,\alpha_0$)^{18}F REACTION AND PRECISION MEASUREMENTS OF LEVELS IN ^{18}F BY THE $^{16}O(^3He,p)^{18}F$ REACTION. Greene, Medley Wayne. Iowa City, Iowa, Univ. of Iowa, 1968. 192p.

Thesis.

The yield and angular distributions of alpha particles from the $^{16}O(^6Li,\alpha_0)^{18}F$ reaction were measured for the bombarding range 4.8 to 13.8 MeV. Nine distinct peaks were observed in the yield curve measured at zero degrees and these peaks had peak-to-valley ratios varying from 1.3 to 6.0. Angular distributions were measured at seven energies: 5.50, 5.70, 6.22, 11.60, 12.20, 12.80, and 13.30 MeV, which, for the most part, corresponds to peak and valley energies observed in the yield curve. The alpha-particle yield curve was interpreted using two models: "cluster interaction" model, and statistical fluctuation model. Conclusions arising from the "cluster interaction" model are: every peak, except for one, observed in the yield curve is correlated to a peak observed in deuteron-induced reactions and, thus, it is believed that ^6Li often interacts as an α-d cluster. An Ericson fluctuation analysis of the yield curve gives a coherence width Γ_0 = 0.49 ± 0.40 MeV (corrected for finite simple size, n = 5.3) in ^{22}Na at an excitation energy range of 18.0 to 24.6 MeV. The autocorrelation analysis predicts a direct reaction contribution to the differential cross section of 0 to 60% in agreement with the qualitative results of the cluster interaction model. The excitation energies of states to 5.00 MeV in ^{18}F were determined to an uncertainty of ±5 keV using the $^{16}O(^3He,p)^{18}F$ (Q = 2.003) reaction. Particle spectra were obtained at two angles for each of four bombarding energies: 5.898, 6.004, 6.099, and 6.200 MeV. The T = 1 isotopic spin states above the α-^{14}N break-up energy (4.42 MeV) were identified by comparing their widths (FWHM) with adjacent T = 0 states. The results obtained agree with the most precise values from other measurements and in some instances, places a smaller uncertainty on excitation energies of ^{18}F. (Disser. Abstr.)

1809 ALPHA–ALPHA COINCIDENCE STUDY OF THE DECAY OF THE 17.28 MeV LEVEL OF ^9Be. Wise, Matthew Norton. Pullman, Wash., Washington State Univ., 1968. 65p.

Thesis.

The decay of the 17.28-MeV level of ^9Be was studied through the reaction $^7Li + d \rightarrow \alpha + \alpha + n$ at E_d = 0.8 MeV. Standard two-parameter techniques, using Si surface-barrier detectors, were employed to detect the two particles in coincidence and display the resulting spectra with 64 × 64 channel resolution. These spectra were projected on one energy axis and were weighted by the inverse of the phase space available at each point to facilitate detailed analysis of the decay mechanisms. The data confirm previous results in that it indicates the greatest proportion of the decay proceeds through the ground state of ^5He. However, by subtracting the ground state peaks from the spectra it has been possible to observe the distribution of decay through the broad first excited state of ^5He. The peak in this distribution shifts widely, from 2.5- to 6-MeV excitation, apparently as a result of order-of-emission interference effects. The peak in the distribution when these effects are minimum lies close to 3 MeV, suggesting this value as the excitation energy to be assigned to the first excited state of ^5He. Spectra were measured in the plane perpendicular to the beam and at 45° to the beam, with approximately 130° between detectors, in an attempt to isolate decay through the 11.5-MeV level of ^8Be and three-body decay, from

decay through ^{5}He. The measured distributions indicate only that if the decay at these positions is through ^{5}He it must be at excitations above 6 MeV. During the course of the experiment, the shape of the peak arising from transitions to the ground state of ^{5}He was measured. From this shape, measured at several angles, the width of the state was determined to be 0.77 ± 0.1 MeV. (Disser. Abstr.)

1810 SIMPLE BUT NEW CALCULATIONS ON SINGLE AND DOUBLE CHARGE-EXCHANGE OF PIONS BY LIGHT NUCLEI. Locci, M. A.; Picchi, P. (CNEN, Rome). Nuovo Cim., 57A: 803-12(Oct. 21, 1968).

The cross section for single and double charge-exchange nuclear reactions with pions for 1p-shell nuclei is calculated using the Glauber method. The results are obtained for the reactions of pions of (80 to 200) MeV by boron ($\pi^+ + {}^{11}B \rightarrow \pi^0 + {}^{11}C$) and lithium ($\pi^+ + {}^{7}Li \rightarrow \pi^- + {}^{7}B$). (auth)

1811 ELASTIC AND INELASTIC SCATTERING OF POLARIZED 2.33 MeV NEUTRONS FROM ^{12}C, $^{54\ 56}$Fe, $^{58\ 60}$Ni, AND ^{65}Cu. Rogers, William Leslie. Cleveland, Case Western Reserve Univ., 1967. 77p.

Thesis.

Time-of-flight techniques were used to observe the scattering of polarized 2.33-MeV neutrons from cylindrical samples of ^{12}C, ^{54,56}Fe, ^{58,60}Ni, and ^{65}Cu. The neutrons were produced by the ^{12}C (d,n) reaction at 30°. Left ($\Phi = \pi$) and right ($\Phi = 0$) counting rates were simultaneously measured for 5 scattering angles between 30 and 120°$_{lab}$. Polarizations and cross sections normalized to the ^{12}C cross section are given for elastic scattering and inelastic scattering. The polarization observed for ^{12}C is in agreement with that calculated from the phase shifts of Wills. The polarization observed for elastic scattering from the other elements was less than 0.2 at all angles. The inelastic angular distributions were predominantly isotropic and the measured inelastic asymmetries were consistent with zero. (Disser. Abstr.)

1812 ANALYSIS OF LOW-ENERGY ^{14}N(^{14}N,^{13}N)^{15}N AND ^{9}Be(^{7}Li,^{8}Li)^{8}Be DATA. Torchia, Dennis Anthony. New Haven, Yale Univ., 1968. 179p.

Thesis.

The nucleon tunneling theory of Breit is employed in the analysis of the ^{14}N(^{14}N,^{13}N)^{15}N and ^{9}Be(^{7}Li,^{8}Li)^{8}Be reaction data. A partial-wave formulation of the theory is applied, using the two-level approximation, neglecting the dynamic reaction terms, and employing the j-j coupling configurations to compute the transfer function β. In the ^{14}N case, an analysis is made of improved measurements of the differential and total cross sections with special attention given to laboratory energies $E_l \leq 16.0$ MeV, which are below the Coulomb barrier. Optical potentials are employed in obtaining fits to the data without dependence on contributions to neutron transfer from internuclear distances small enough to cause appreciable coalescence of the two nuclei. Potentials are found which simultaneously provide fits to the ^{14}N−^{14}N elastic scattering data and the neutron transfer data. The reduced width obtained from the transfer analysis was found to be slightly larger than the single-particle width employed in the ^{14}N−^{14}N elastic scattering work of McIntosh, Park and Rawitscher, and in rough agreement with the reduced width obtained from the long-range tail of the non-Coulombian part of the nucleus-nucleus potential. In applying the theory to ^{9}Be(^{7}Li,^{8}Li)^{8}Be, fits were not obtained to the angular distribution data at large angles. Possible sources of the discrepancy between theory and experiment are discussed. (Diss. Abstr.)

1813 ENERGY AND ANGULAR DISTRIBUTION OF α PARTICLES IN THE ^{14}N(n,α)^{11}B REACTION AT 14.1 MeV. Hsu, Yuin-chi; Huang, Chia-yi; Chang, Ching-ching (National Taiwan Univ., Taipei). Chin. J. Phys. (Peking) (Engl. Transl.), 6: 1-6(Apr. 1968).

The ^{14}N(n,α)^{11}B reaction leading to the first five states of ^{11}B was studied by using a cloud chamber at 14.1-MeV neutron energy. The angular distributions of α particles present evidence for the belief that the reaction proceeds by the direct reaction mechanism. The theoretical fits to the angular distributions are discussed in terms of heavy-particle stripping and knock-on processes. (auth)

1814 THE ^{12}C(^{3}He,p)^{14}N REACTION BETWEEN 3 AND 4 MeV. Cloud, Stanley Donovan. Eugene, Oreg., Univ. of Oregon, 1968. 202p.

Thesis.

The ^{12}C(^{3}He,p)^{14}N reaction was investigated for ^{3}He energies between 3.0 and 4.05 MeV. Angular distributions of protons leading to the ground state and first two excited states of ^{14}N were measured at 11 energies. Excitation curves for production of the same protons were obtained at laboratory angles of 20, 60, 120, and 160°. A 4-MeV Van de Graaff accelerator produced the ^{3}He beam. Silicon surface-barrier detectors were used inside an 11-inch reaction chamber to detect the protons. Particle spectra were accumulated and analyzed by means of an on-line PDP-7 digital computer. The angular distributions were expanded as sums of Legendre polynomials of maximum order 6 by means of a least-squares fitting procedure. Over the energy interval from 3.3 to 4.05 MeV, the fifth-order Legendre polynomial was found to make a significant contribution for all three proton groups, peaking at approximately 3.7 MeV. For p_0, the distributions are forward peaked except near 3.9 Mev and have a second peak near 120 degrees in the center of mass system. As the ^{3}He energy increases, the forward peak decreases while the 120° peak maintains its height but moves slowly toward forward angles (130° at 3.00 MeV, 110° at 3.43 MeV). Above 3.6 MeV, the 120° peak gives way to more backward-angle structure as both the third- and fourth-order Legendre polynomial contributions decrease sharply. At 3.87 MeV, there are three distinct peaks at 0, 75, and 145° in the center-of-mass system. The p_1 distributions are nearly symmetric about 90° from 3.00 MeV to about 3.5 MeV, when the odd Legendre polynomials begin to contribute. Above 3.7 MeV, the distributions are strongly backward peaked. The p_2 distributions are consistently strongly forward peaked with a small secondary peak at 110 to 130°. The position of the secondary peak shifts with energy as does the overall amplitude. An interpretation of the angular distributions from the compound-nucleus reaction point of view in terms of resonances at 2.4, 2.75, 3.0, 3.3, 3.55, and 4.2 MeV is discussed. (Diss. Abstr.)

1815 POLARIZATION EFFECTS IN THE ^{6}Li(d,α)^{4}He REACTION. Burcham, W. E.; Griffith, J. A. R.; Karban, O.; Mani, G. S.; Roman, S. (Univ. of Birmingham, Eng.). Nucl. Phys., A120: 145-51(1968).

The ^{6}Li(d,α)^{4}He reaction induced by vector polarized deuterons was investigated at five incident deuteron energies between 4 and 12 MeV. The asymmetry of the reaction was measured for each energy as a function of reaction angle, and large asymmetries were observed. The reaction would be suitable as a vector polarization analyzer between 6 and 11 MeV. The results were fitted with an expansion of associated Legendre polynomials requiring high angular momentum values up to l = 8. (auth)

1816 ELASTIC AND QUASI-FREE ELECTRON SCATTERING FROM ^{12}C AND PROJECTED HARTREE–FOCK WAVE FUNCTIONS. Boffi, S. (Univ., Pavia, Italy); Bouten, M.; Ciofi delgi Atti, C.; Sawicki, J. Nucl. Phys., A120: 135-44(1968).

Projected Hartree–Fock wave functions were obtained for ^{12}C and ^{11}B using Volkov's force. The elastic electron scattering form factor and the angular and energy distributions for the high-energy ^{12}C(e,e'p) reaction are calculated. While a good agreement is obtained with the observed elastic form factor only a slight improvement over previous shell-model results is obtained for the quasi-free scattering data. The relatively large deformation of the Hartree–Fock field has only a negligible effect on the calculated form factors. (auth)

1817 BOMBARDMENT OF ^{14}N BY ^{6}Li IONS. Rice, L. R.; Carpenter, R. T. (Univ. of Iowa, Iowa City). Nucl. Phys., A120: 220-4(1968).

Thick adenine ($C_5H_5N_5$) targets were used to investigate the reaction of ^{6}Li ions with ^{14}N. Relative angular distributions at bombarding energies of 5.3, 5.64, and 6.0 MeV were determined for protons, deuterons, and alphas leading to the lower states in ^{19}F, ^{18}F, and ^{16}O, respectively. A yield curve was obtained between 4.1 and 6.3 MeV to compare the cross sections at the various energies. (auth)

1818 WIDTHS OF LOW-LYING LEVELS OF ^{6}Li. Creten, W. L.; Jacobs, R. J.; Ferdinande, H. M. (Univ., Ghent). Nucl. Phys., A120: 126-34(1968).

The bremsstrahlung of electrons from a linear accelerator was used to excite two levels of ^{6}Li. From self-absorption measurements, the following width was obtained: $\Gamma_\gamma(3.56\ \text{MeV}) = 4.6 \pm 0.4$ eV and from a scattering experiment: $\Gamma_\gamma(2.18) < 140\ \mu$eV. As a check on the apparatus and method, the well-known widths of two levels in ^{11}B and ^{28}Si were measured. (auth)

1819 HOLE-PARTICLE STATES IN ^{18}F. Middleton, R.; Polsky, L. M.; Holbrow, C. H.; Bethge, K. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett., 21: 1398-1401(Nov. 4, 1968).

Using the reaction ^{14}N(^{7}Li,t)^{18}F hole-particle configurations were assigned to ten states of ^{18}F. The results support a model which assumes weak coupling between holes and particles. It was also found that the reaction obeys a $\Delta T = 0$ selection rule. (auth)

1820 CHARACTERISTICS OF PARTICLE PRODUCTION IN THE INTERACTION OF 22.8 GeV/c PROTONS WITH LIGHT NUCLEI IN EMULSION. Bhowmik, B.; Shivpuri, R. K. (Univ. of Delhi). Can. J. Phys., 46: 2527-32(Nov. 15, 1968).

The present work is aimed at the study of the characteristics of particle production in interactions between proton and light nuclei. The features studied are angular distribution, inelasticity, transverse momentum, and center-of-mass momentum of

the secondary particles. In order to determine the contribution of multinucleon collisions, the results were compared with those of proton–nucleon interactions. It was found that, whereas the features of low-multiplicity events closely resemble the similar events from p–N collisions, those of high-multiplicity events are somewhat modified by the occurrence of intranuclear interactions. (auth)(CANADA)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 296, 671, 681, 1165, 1793, 1795, 1796, 1805, 1811, 1812, 1818, 1878–1882, 1929, 1955, and 1962.

1821 (COO-1549-10) NUCLEAR PHYSICS STUDIES USING NUCLEAR EMULSIONS. Technical Progress Report. (Wyoming Univ., Laramie). Aug. 1, 1968. Contract AT(11-1)-1549. 38p. Dep. CFSTI.

Neutron energy spectra and angular distributions from the reactions of 26-MeV protons with ^{63}Cu and ^{60}Ni were measured. The efficiency of a double scintillator neutron time-of-flight spectrometer was investigated; a method for achieving γ background suppression in proton-recoil spectrometers was developed. Computer simulation studies of the effects of various parameters upon the efficiency and resolution of the neutron time-of-flight spectrometer were initiated; the response of the organic scintillator to fast neutrons was studied in detail. An attempt to observe ^{64}Ge through the ^{64}Zn(^{3}He,3n)^{64}Ge reaction was made. The reaction of 160-MeV ^{16}O ions with ^{58}Ni was investigated; experimental data were analyzed in terms of the transfer of an α particle or of a ^{12}C nucleus and in terms of the complete fusion of ^{16}O with the target nucleus. (D.C.W.)

1822 (INP-626) LOW EXCITED STATES OF ^{54}Mn. Balanda, A.; Gasior, M.; Lizurej, H. I.; Niewodniczanski, H. (Institute of Nuclear Physics, Krakow (Poland)). July 1968. 9p. (In Polish). Dep.

Low-lying excited states of ^{54}Mn were investigated by means of the reaction ^{54}Cr(p,n)^{54}Mn at E_p = 2.7 MeV. The energies of the two first excited states at 54.3 ± 0.5 and 156.9 ± 1 keV were determined from the internal conversion electron spectrum. The ratio of internal conversion coefficients $\alpha_K/\alpha_L + \alpha_M$ for the 54.3-keV transition was found to be 7.1 ± 1. (auth)

1823 (ITEF-596) PARTICLE–HOLE CONFIGURATIONS OF EVEN–EVEN NUCLEI OF ^{60}Ni, ^{64} ^{66}Zn. Okorokov, V. V.; Serezhin, V. M.; Smotryaev, V. A.; Tolchenkov, D. L.; Trostin, I. C.; Cheblukov, Yu. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1968. 18p. (In Russian). Dep.

The highly excited states of ^{60}Ni, ^{64}Zn, and ^{66}Zn were investigated using the reactions ^{59}Co(d,n)^{60}Ni, ^{63}Cu(d,n)^{64}Zn, and ^{65}Cu(d,n)^{66}Zn. The cross sections of the (d,n) reactions were compared with distorted-wave calculations. Particle-hole configurations were attributed to the states in ^{60}Ni, ^{64}Zn, and ^{66}Zn. (D.C.W.)

1824 (N-68-29375) GAMMA RAY ANGULAR CORRELATIONS FOLLOWING INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES FROM ^{24}Mg. Leonard, Regis F.; Stewart, William M.; Baron, Norton; Braley, Richard C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). July 1968. 28p. (NASA-TN-D-4683). CFSTI.

The angular correlation between inelastically scattered 42-MeV alpha particles and gamma rays emitted in the subsequent nuclear decay was studied for the 1.37-MeV state of ^{24}Mg. The symmetry angle of the gamma distribution and the magnitude of the anisotropy of the gamma distribution were measured for alpha scattering angles between 30 and 76°. The results are compared with the distorted-wave predictions and with the adiabatic and Wills–Cramer models. Observed symmetry angles do not display the large excursions away from the adiabatic line which were seen in earlier work on ^{24}Mg at lower energies and more forward angles. (auth) (STAR)

1825 (NP-17579, pp III.12-17) LOW-ENERGY NUCLEAR PHYSICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Previously unreported research on the yields of ^{83}As and ^{84}As in thermal neutron fission of ^{235}U; chemical effects on the half-life of ^{239m}U; ^{101}Mo γ transitions from neutron capture by ^{100}Mo; the energy levels of ^{56}Mn as observed through neutron capture by ^{55}Mn; the γ spectrum from the ^{60}Ni(n,γ)^{61}Ni reaction; and projected Hartree–Fock calculations for light nuclei is summarized. In addition, the successful drifting of planar Ge detectors using zone-leveled Ge single crystals is reported, as is a shell-model calculation of the low-lying levels of ^{58}Cu. (D.C.W.)

1826 (ORNL-TM-2309) ELECTRODISINTEGRATION OF ALUMINUM, IRON, NICKEL, AND COPPER AT 13.3 AND 16.0 GeV. Callis, Ernest L. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 60p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

Absolute cross sections were measured for the production of several radionuclides by 13.3-GeV electrodisintegration of aluminum, iron, nickel, and copper. Relative yields of radionuclides produced by 16.0-GeV electrodisintegration of aluminum and iron were also measured. Foil samples of target materials were bombarded in electron beams at the Stanford Linear Accelerator. Gamma spectra of the residual radioactivity were measured with Ge(Li) spectrometers. Nuclides were identified by gamma energy and half-life. Yields of nuclides of a given element were observed to peak near the stable valley. The yields exhibit a pattern that indicates cascade-evaporation reactions are important. Unusually large yields of ^{32}P and ^{24}Na in iron targets and ^{15}O and ^{11}C in aluminum targets were observed; these are consistent with fission of the target nuclei. (auth)

1827 (UCRL-18414) THE EXCITATION OF UNNATURAL-PARITY STATES IN ^{24}Mg, ^{20}Ne, AND ^{16}O BY INELASTIC α SCATTERING. Reed, Mary (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. 131p. Dep. CFSTI.

Thesis.

The excitation of unnatural-parity states ($\pi \neq (-)^J$) in even-even nuclei was studied by inelastic α scattering over the energy range of 33 to 120 MeV. Data are reported for the low-lying states in the three nuclei ^{24}Mg, ^{20}Ne, and ^{16}O. The excitation of unnatural-parity states is forbidden in simple, one-step, direct reaction theories by spin and parity considerations. Since these states are excited with moderately large cross sections, the study of them sheds light on more complicated reaction mechanisms. When the angular distributions for these reactions at the various energies are compared with each other, consistent results are obtained for the natural-parity states and for the 2^- state in ^{16}O. However, for the 2^- state in ^{20}Ne and the 3^+ state in ^{24}Mg, unusual angular distributions are obtained which bear no resemblance to the theories. Calculations of compound-nucleus and multiple excitation cross sections were made using Hauser–Feshbach and coupled-channel computer codes. The multiple excitation cross sections produced in this way give fairly good agreement with the experimental data, even reproducing the unusual appearance of the 3^+ angular distributions. Thus the excitation of the unnatural parity state in ^{24}Mg is determined to be mainly a multiple-step process. (auth)

1828 DIRECTIONAL CORRELATIONS OF GAMMA RAYS IN THE DECAY OF 36-hr ^{82}Br. Gupta, S. L.; Bajaj, M. M. (Univ. of Delhi). Aust. J. Phys., 21: 649-60(Oct. 1968).

Coincidence and gamma–gamma directional correlation measurements are made for the 10 cascades of ^{82}Kr: 1648–777, 1008–1044, 1317–777, 619–1475, 555–1317, 555–619, 828–1044, 828–(1044)–777, 698–777, and 619–698 keV, of which the cascade 1008–1044 keV was attempted for the first time. The results permit a unique spin assignment of 5 for the 2829-keV level from the directional correlation of the 1008–1044 keV cascade and a spin of 3 to the level at 2425 keV from that of the 1648–777 keV cascade. Multipole character and admixture are determined for the transitions of 1648, 1475, 1044, 1008, 555, 828, 698, 619, and 1317 keV. Computed E2 partial half-lives for the last two transitions are compared with the predictions of the single-particle estimate and the nonaxial rotor model. (auth)

1829 POLARIZATION OF NEUTRONS FROM THE REACTION ^{28}Si(d,n)^{29}P AT E_d = 5.0 MeV. Lam, S. T.; Gedcke, D. A.; Stinson, G. M.; Tang, S. M.; Sample, J. T. (Univ. of Alberta, Edmonton, Can.). Nucl. Phys., A119: 146-60(1968).

The polarization angular distributions of neutrons from the reaction ^{28}Si(d,n)^{29}P leading to the ground, 1.38 and 1.96 MeV states of ^{29}P at a deuteron energy of 5.0 MeV were measured by means of a liquid helium polarimeter and neutron time-of-flight technique. The polarization angular distribution of the ground state group (l_p = 0) is in good qualitative agreement with the derivative rule. Spin-dependent effects are observed in the neutron polarization angular distributions for the transitions to the 1.38 ($j = l_p - \frac{1}{2}$) and the 1.96 ($j = l_p + \frac{1}{2}$) MeV states. A DWBA calculation of the polarizations was carried out. Fair agreement between calculation and measurement is found for the ground-state transition; for the transitions to the 1.38- and 1.96-MeV states the agreement is relatively poor. (auth)

1830 NEUTRON RESONANCE MEASUREMENTS WITH A GERMANIUM DETECTOR. Bird, J. R.; Kenny, M. J.; Allen, B. J. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Phys. Lett., 27B: 638-40(Oct. 14, 1968).

A Ge(Li) detector is shown to be suitable for the observation of resonances and the measurement of partial and total capture cross sections for neutrons with energies greater than 5 keV. (auth)

1831 SHELL-MODEL CALCULATION FOR NUCLEI OF MASSES 30 THROUGH 33. Wildenthal, B. H. (Oak Ridge National Lab., Tenn.); McGrory, J. B.; Halbert, E. C.; Glaudemans, P. W. M. Phys. Lett., 27B: 611-13(Oct. 14, 1968).

Level energies and spectroscopic factors for isotopes of P, Si, and S are calculated with a shell model which includes active particles in the $1d_{\frac{3}{2}}$, $2s_{\frac{1}{2}}$, and $1d_{\frac{5}{2}}$ shells. (auth)

1832 INVESTIGATIONS OF THE NUCLEAR MAGNETIC RESONANCE OF ALKALI METAL NUCLEI IN AQUEOUS SOLUTIONS. Lutz, O. (Univ., Tuebingen, Ger.). Z. Naturforsch., 23a: 1202-9(Aug. 1968). (In German).

The NMR signals of the nuclei ^{2}H, ^{6}Li, ^{7}Li, ^{23}Na, ^{87}Rb, and ^{133}Cs were investigated in aqueous solutions. The ratios of the Larmor frequencies of these alkali nuclei relative to ^{2}H have been measured with high accuracy. Because the Larmor frequencies depend on the concentration of the aqueous solutions, an extrapolation to vanishing concentration was made. From these ratios of Larmor frequencies, a magnetic moment for the alkali nuclei was derived and was compared with the available nuclear magnetic moments from atomic beam or optical pumping experiments. The difference in the magnetic moments results from the shielding of the alkali nuclei by the water molecules around the ions. The shielding constants are: $\sigma(Rb^{+}) = -2.0 \pm 0.2 \times 10^{-4}$ and $\sigma(Cs^{+}) = -3.4 \pm 0.1 \times 10^{-4}$ relative to the free ion. The shift of the ^{133}Cs NMR line as a function of the concentration of aqueous solutions of Cs-salts is given in detail. The influence of the chlorides of some elements in the iron group and of some lanthanide elements on the position of the ^{133}Cs NMR line is shown. (auth)

1833 CALCULATION OF NEUTRON INELASTIC SCATTERING CROSS SECTIONS. Goldsmith, Mark (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 34: 93-7 (Nov. 1968).

Hauser-Feshbach calculations of the cross sections for producing selected excited states of ^{27}Al, ^{56}Fe, and ^{90}Zr are compared with experiment. It is found that, in addition to the usual width fluctuation correction factor, modified optical model transmission coefficients are necessary. A simple approximate formula, due to Feshbach, for the modified transmission coefficient is found to give good overall agreement with experiment. (auth)

1834 $T = \frac{3}{2}$ STATES IN ^{21}Ne. Hensley, D. C. (California Inst. of Tech., Pasadena). Phys. Lett., 27B: 644-6(Oct. 14, 1968).

Five $T = \frac{3}{2}$ states in ^{21}Ne were observed in the $^{22}Ne(^{3}H,\alpha)^{21}Ne$ reaction, and l_n values were assigned to the respective angular distributions where possible. Two completed $T = \frac{3}{2}$ quartets in mass 21 are found to deviate significantly from the quadratic mass equation for isobaric multiplets. (auth)

1835 DECAY CHARACTERISTICS OF ^{84}Se. Rengan, K.; Griffin, Henry C. (Univ. of Michigan, Ann Arbor). pp 179-85 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The decay characteristics of ^{84}Se were studied. This nuclide was found to have a half-life of 3.1 ± 0.2 min and to decay predominantly by a 1400 ± 100-keV beta transition followed by a 399 ± 5-keV gamma ray. No other gamma rays were detected in the decay. A beta transition to the ground state of ^{84}Br was not detected, and an upper limit of 10% is placed for this mode of decay. The 399-keV level and the ground state of ^{84}Br are interpreted as 1^{+} and 2^{-}, respectively. (auth)

1836 HYPERFINE STRUCTURE OF ^{67}Ga AND ^{72}Ga. Ehlers, Vernon J.; Kabasakal, Yurdanur; Shugart, Howard A.; Tezer, Orhan (Univ. of California, Berkeley). Phys. Rev., 176: 25-42(Dec. 5, 1968).

The atomic-beam magnetic-resonance technique was used to measure the hyperfine-structure separations and the differential hyperfine-structure anomalies of 78-hr ^{67}Ga and 14-hr ^{72}Ga in the $^{2}P_{\frac{3}{2}}$ and $^{2}P_{\frac{1}{2}}$ electronic states. From the differential hyperfine-structure anomaly, the standard hyperfine-structure anomaly was determined for the two J states. The nuclear moments were also calculated from the measured hyperfine-structure separations. The results are, for ^{67}Ga (I = $\frac{3}{2}$): $\Delta\nu(^{2}P_{\frac{3}{2}}) = 2457.727\ 26(90)$ MHz, $a(^{2}P_{\frac{3}{2}}) = 175.097\ 36(15)$ MHz, $b(^{2}P_{\frac{3}{2}}) = 71.957\ 50(55)$ MHz, $^{67}\delta^{69} = 2.51(13) \times 10^{-5}$, $^{67}\Delta^{69}(^{2}P_{\frac{3}{2}}) = 5.0(1.4) \times 10^{-6}$, $^{67}\Delta^{69}(^{2}P_{\frac{1}{2}}) = -20.1(2.0) \times 10^{-6}$, $\mu_I(\text{uncorr}) = +1.8454(3)\mu_N$, and Q = +0.22 b; and for ^{72}Ga(I = 3): $\Delta\nu(^{2}P_{\frac{3}{2}}) = -153.652\ 66(53)$ MHz, $a(^{2}P_{\frac{3}{2}}) = -6.256\ 98(11)$ MHz, $b(^{2}P_{\frac{3}{2}}) = 193.673\ 65(80)$ MHz, $^{71}\delta^{72} = 2.12(18) \times 10^{-4}$, $^{71}\Delta^{72}(^{2}P_{\frac{3}{2}}) = 4.2(1.2) \times 10^{-5}$, $^{71}\Delta^{72}(^{2}P_{\frac{1}{2}}) = -17.0(2.0) \times 10^{-5}$, $\mu_I(\text{uncorr}) = -0.131\ 86(2)\mu_N$, Q = +0.59 b. The quoted values of the nuclear magnetic moments include a correction for the hyperfine-structure anomaly, but do not include the diamagnetic correction. (auth)

1837 SHORT-LIVED NUCLIDES FORMED BY (γ,n) REACTIONS WITH 20-MeV BREMSSTRAHLUNG. Oka, Yoshinaga; Kato, Toyoaki; Yamadera, Akira (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 41: 1606-10(July 1968).

The most prominent (γ,n) reaction products with half-lives from 10 sec to about 1 min formed by irradiation of some 7 elements with 20-MeV bremsstrahlung were determined in order to study the applicability of these products to photoactivation analyses. Irradiation was carried out for 1 min with 20-MeV bremsstrahlung radiation with a dose rate of 10^{7} R/min. The reactions investigated were: $^{24}Mg(\gamma,n)^{23}Mg$, $^{76}Ge(\gamma,n)^{75m}Ge$, $^{78}Se(\gamma,n)^{77m}Sc$, $^{92}Mo(\gamma,n)^{91m}Mo$, $^{140}Ce(\gamma,n)^{139m}Ce$, $^{142}Nd(\gamma,n)^{141m}Nd$, and $^{159}Tb(\gamma,n)^{158m}Tb$. The yields of these reactions were obtained through the absolute measurement of resultant activities. The isomeric yield ratios are discussed on the basis of the nuclear properties of the residual nuclides. The observed ratios generally favor the isomer whose spin is closer to that of the target nucleus. For the elements studied, the lower limits of detection averaged about 1 μg under present experimental conditions. (auth)

1838 PROTON POLARIZATION IN SCATTERING AT 185 MeV FROM INDIVIDUAL STATES OF ^{24}Mg. Hoeistad, B.; Ingemarsson, A.; Johansson, A.; Tibell, G. (Uppsala Univ.). Nucl. Phys., A119: 290-304(1968).

The polarization of 185-MeV protons elastically and inelastically (-Q = 1.37, 4.21, 6.01, 6.44, 7.60, and 8.38 MeV) scattered from magnesium was measured in the region 7.5° 40° (lab system). The energy levels studied were selected with the aid of a magnetic spectrometer giving a total energy resolution of 0.7 MeV FWHM. The polarimeter was calibrated using published polarization data at 154 and 138 MeV. The angular distributions obtained were found to be very similar in shape and showed a first maximum for a scattering angle of about 20° and oscillations for larger scattering angles. (auth)

1839 FLUCTUATION ANALYSIS OF NEUTRON TOTAL CROSS SECTIONS BETWEEN 3.2 AND 5.2 MeV. Manero, F.; Vigon, M. A. (Junta de Energia Nuclear, Madrid). Nucl. Phys., A119: 356-68(1968).

An analysis of the fluctuations observed in previous measurements of the neutron total cross sections of V, Cr, Mn, Co, As, In, I and Bi in the energy range 3.2 to 5.2 MeV is presented. For the fluctuation analysis, the autocorrelation method and an averaging procedure were used. The reported fluctuations can not be explained with the Ericson theory, but they may be considered as a superposition of a gross structure belonging to the intermediate resonances and of statistical fluctuations in the widths and spacings of the compound nucleus. The estimations of the mean level width from the neutron cross section fluctuations are in good agreement with the known values of Γ. (auth)

1840 STUDY OF ^{52}Cr, ^{54}Cr, AND ^{56}Cr BY THE (t,p) REACTION. Chapman, R. (Atomic Weapons Research Establishment, Aldermaston, Eng.); Hinds, S.; MacGregor, A. E. Nucl. Phys., A119: 305-24(1968).

The (t,p) reactions leading to $^{52,54,56}Cr$ were investigated at a bombarding energy of 12 MeV, using the Aldermaston multi-angle magnetic spectrograph. Levels in the final nuclei were measured for excitation energies below 5 to 6 MeV. A number of 0^{+}, 2^{+}, 3^{-}, and 4^{+} states were identified from the shapes of the proton angular distributions. The results are compared with previous assignments where possible, and good agreement is obtained. The strongest L = 0 transitions in each of the reactions $^{50,52,54}Cr(t,p)$ are those to the 2.663-MeV excited state of ^{52}Cr and to the ground states of ^{54}Cr and ^{56}Cr. This is in agreement with the previously observed trend in (t,p) reactions. The level structure of ^{52}Cr and ^{54}Cr is compared with theoretical calculations. (auth)

1841 ELASTIC AND INELASTIC SCATTERING ON 34.4-MeV ALPHA PARTICLES BY ^{58}Ni AND ^{60}Ni. Inoue, Makoto (Osaka Univ.). Nucl. Phys., A119: 449-66(1968).

Angular distributions were measured for elastic and inelastic alpha-particle scattering by ^{58}Ni and ^{60}Ni using the 34.4-MeV alpha beam of the INS Tokyo cylotron. Scattered alpha particles were detected with a broad-range magnetic analyzer and/or a semiconductor detector. About 40 angular distributions, which included those corresponding to the so-called two-phonon triplet states of ^{60}Ni, were obtained. The elastic-scattering data were analyzed using the optical model. A diffraction theory and a distorted-wave theory were applied to analyze all the inelastic groups. The inelastic scattering leading to the first 2^{+}, the second 2^{+} and the first 4^{+} excited states of ^{58}Ni was analyzed using form factors of a microscopic model. The so-called two-phonon states, some possible 3^{-} states other than the most prominent ones and possible higher-spin (5^{-}, 6^{+}) states are discussed. (auth)

1842 E2 TRANSITIONS AND THE INTRINSIC STRUCTURE OF THE 1f-2p SHELL NUCLEI. Bhatt, K. H. (Oak Ridge National Lab., Tenn.); Parikh, J. C.; Svenne, J. P. Phys. Rev. Lett., 21: 1354-7(Oct. 28, 1968).

An attempt is made to understand the relation between the experimental B(E2; $I_i \rightarrow I_f$) values for different nuclei in the first half of the 1f-2p shell in terms of the structure of the intrinsic single-particle orbits resulting from deformed Hartree–Fock calculations for these nuclei. (auth)

1843 OPTICAL-MODEL ANALYSIS FOR ^{3}He SCATTERING FROM SOME LIGHT NUCLEI IN THE ENERGY RANGE 18 TO 20 MeV. Kattenborn, H.; Mayer-Boericke, C.; Mertens, B. (Max-Plack-Inst. for Nuclear Physics, Heidelberg. Kernforschungsanlage, Juelich, Ger.). Nucl. Phys., A119: 559-67 (1968).

Angular distributions for ^{3}He elastic scattering by ^{24}Mg, ^{28}Si, ^{30}Si, and ^{32}S have been measured at 18 and 20 MeV incident energy in the angular range $15° \leq \theta \leq 100°$ and analyzed in terms of an optical model. A detailed optical model analysis of the ^{28}Si data showed the existence of ambiguities, due to different numbers of half-waves inside the potential well. The influence of experimental uncertainties on optical parameter determination has been investigated as well as the effect of a spin-orbit term on the shape of the angular distribution. (auth)

1844 SPIN-1 STATES IN ^{48}Ti. Monahan, C. F.; Dawson, N.; Main, I. G.; Thomas, M. F.; Twin, P. J. (Univ. of Liverpool). Nucl. Phys., A119: 550-8(1968).

Particle-gamma-ray angular correlations were used to assign spin 1 to the levels at 3.710 MeV, 3.752 MeV, and 4.048 MeV in ^{48}Ti. The mixing ratios of the transitions from the 3.710- and 3.752-MeV levels to the 2^+ level at 0.983 MeV were measured as $\delta = -0.87$ and $3.37 > \delta > -0.09$, respectively. The results are discussed with reference to the shell model. (auth)

1845 PARTICLE-HOLE EXCITATIONS IN ^{48}Ca. Jaffrin, A.; Ripka, G. (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A119: 529-49(1968).

A description of the known collective and non-collective odd-parity levels of ^{48}Ca is obtained by means of particle-hole excitations with an interaction that gave good results in other nuclei. The absence of pairing effect in ^{48}Ca was tested. Correlations in the ground state by the use of the RPA were necessary to obtain correct energies. Reasonable transition rates are obtained without any effective charge. However, this particle-hole model is not able to describe even-parity states. (auth)

1846 RADIATIVE CAPTURE CROSS SECTIONS IN MEDIUM-WEIGHT AND HEAVY NUCLEI. Daly, P. J. (Rutherford High Energy Lab., Chilton, Eng.); Seppelt, B. M.; Shaw, P. F. D. Nucl. Phys., A119: 673-90(1968).

Induced radioactivity methods were used to measure radiative capture cross sections of alpha particles in ^{139}La (bombarding energy 10 to 36 MeV), tritons in ^{138}Ba (6 to 13 MeV), deuterons in ^{139}La and ^{30}Si (6 to 18 MeV), and protons in ^{82}Se and ^{100}Mo (5 to 50 and 5 to 20 MeV, respectively). The results are difficult to reconcile with statistical theory. The direct radiative capture cross section calculated for the two proton capture reactions when enhanced by the particle-hole interaction approximates the experimental data over the entire energy range. (auth)

1847 A STATISTICAL ANALYSIS OF THE ^{31}P(d,α)^{29}Si REACTION. Lock, George Allen. Austin, Tex., Univ. of Texas, 1968. 107p.

Thesis.

Cross sections for the reaction ^{31}P(d,α)^{29}Si were measured for laboratory deuteron energies from 7.300 to 12.020 MeV. The data were analyzed in terms of Ericson fluctuation theory from which the coherence width in ^{33}S was obtained for the whole range of data and for the data divided into halves. The fraction of the reaction proceeding via a direct mechanism was also determined by Ericson-type analysis. To obtain this fraction, it was necessary to take into account the particle decay of 3,040 channels from the compound nucleus in order to calculate realistically the fluctuation damping coefficient. An effort was made to obtain the spins of the fourth, fifth, and sixth excited states in ^{29}Si by a judicious application of the 2I + 1 rule. (Disser. Abstr.)

1848 STRUCTURE OF ^{60}Ni, ^{46}Ti, AND ^{28}Si AS INVESTIGATED BY 37.7 MeV (^{3}He,d) AND 21.2 MeV (p,p') SCATTERING STUDIES. Barnard, Ralston White. Boulder, Colo., Univ. of Colorado, 1968. 216p.

Thesis.

The structure of ^{60}Ni, ^{46}Ti, and ^{28}Si was studied by means of the (^{3}He,d) proton transfer reaction on ^{59}Co, ^{45}Sc, and ^{27}Al targets, and by means of (p,p') inelastic scattering on ^{60}Ni, ^{46}Ti, and ^{28}Si. Angular distributions for elastically scattered ^{3}He were obtained in the angular range 5 to 90° for all nuclei and to 150° for ^{59}Co. Reaction angular distributions were obtained from 10° to about 70° for all nuclei. The proton elastic and some strongly excited inelastic scattering angular distributions were obtained from 10 to 150° for all target nuclei, while those of the weaker states were observed to 130°. Energy resolution was of the order of 80 keV and 50 keV for the ^{3}He and proton scattering respectively. Analysis of the (^{3}He,d) and (p,p') data employs the distorted-wave Born approximation (DWBA). The (p,p') analysis involves both the collective and shell models. Analysis of ^{3}He elastic scattering was made to obtain a number of optical potentials. The various potentials include some of the optical model ambiguities and various combinations of optical model terms. It was found that a potential with a real well depth near 170 MeV and a real radius of approximately $1.15A^{\frac{1}{3}}$ fm provides the best fit to both elastic scattering and reaction data. Other investigations showed that the optimized spin-orbit and the surface absorptive strengths of the potential are both small. It was also found that changes in optical model parameters obtained by fitting the elastic scattering data out to 90 instead of 150° have little effect on DWBA calculations for the (^{3}He,d) angular distributions. Analysis of the (^{3}He,d) data shows the distorted-wave theory to be a powerful method for obtaining spectroscopic and structural information. Several excited states of ^{46}Ti and ^{28}Si were tentatively assigned new spins and parities, and spectroscopic analyses of the three nuclei were performed. It was found that the ground-state spectroscopic strengths for ^{60}Ni and ^{28}Si, which each have only one proton hole available, are significantly depleted from unity. Angular distributions of some of the excited states appeared to be formed from incoherent mixtures of angular momentum transfers; extraction of the components indicated possible fragmentation of the ground state spectroscopic strength. The proton inelastic scattering analysis was carried out in an attempt to describe some of the inelastic proton angular distributions in terms of simple shell model configurations. The shell model form factors used in DWBA calculations were selected such that the particular particle-hole configurations satisfy both (^{3}He,d) and (p,p') analyses. In addition, a collective model analysis was performed; deformation parameters are presented and spins are assigned to some higher states of ^{46}Ti. These analyses do not provide as much information as desired, primarily because of the lack of sensitivity to angular momentum transfers and configurations. The configurations of excited states deduced from the shell-model analyses are not inconsistent with those predicted by the (^{3}He,d) analysis. The wide variation in two-body effective interaction potential V_0 noted may reflect primarily the absence or presence of collective contributions to the cross section rather than any basic inaccuracy in the form factor. (Disser. Abstr.)

1849 PROTON POLARIZATION IN THE ^{40}Ca(d,p)^{41}Ca REACTION. Kelley, Charles Thomas Jr. Bloomington, Ind., Indiana Univ., 1968. 116p.

Thesis.

The distorted wave Born approximation theory has so far been unable to satisfactorily predict the polarization of protons in a (d,p) stripping reaction. Recently, two new theories (the sudden approximation and the weakly bound projectile model) have been published in the literature. Proton polarizations corresponding to several final states in a stripping reaction that has been studied by the above theories were measured in order to compare the proton polarization predictions and to provide new data for additional future theoretical analysis. The polarization of protons corresponding to the ^{40}Ca(d,p)^{41}Ca ground state, 1.95-, and 2.47-MeV reactions were measured at 13 angles between 30 and 148° (lab) at a deuteron bombarding energy of 10.8 MeV. A carbon polarimeter using solid-state detectors permitted the measurements for all three proton groups to be made simultaneously. The detector systems on both sides of the polarimeter consisted of a thin fully depleted transmission detector (ΔE) and a partially depleted thick detector (E). In order to reduce the number of background counts in the spectra, a fast-slow coincidence requirement was imposed between the respective ΔE and E detectors. The intrinsic asymmetry of the polarimeter was measured for each proton group at all angles, and a solid-angle correction, due to the non-uniform illumination of the carbon analyzer by protons from the calcium target, was made to the product polarization. The polarization results for the ground-state reaction ($l_n = 3$, $j_n = \frac{7}{2}$) are in good agreement with previous results at a similar deuteron bombarding energy, although the present work extended over a wider angular range. A comparison between the ground-state proton polarization and the three theories mentioned above was made, although the theoretical predictions are only considered to be preliminary. Reasonable agreement was found with the sudden approximation. Polarization angular distributions for protons corresponding to the 1.95- and 2.47-MeV reactions agree with previous results, taken at a deuteron bombarding energy of 15

MeV, in the forward direction where the angular regions studied overlap. For these reactions, it is expected that the proton polarization angular distributions would be similar, since $l_n = 1$ and $j_n = 3/2$ for both reactions, and the ^{41}Ca final states are separated by just 520 keV. This intuitive behavior was found to be correct except possibly near 100°. Since this is the same region where the ^{40}Ca(d,p)^{41}Ca 3.95-MeV ($l_n = 1$, $j_n = 1/2$) reaction exhibits a so-called "j-dependent minimum" in the (d,p) differential cross section, a connection between the possible anomalous behavior of the proton polarization and the j-dependent minimum was suggested. The proton polarization corresponding to the ^{40}Ca(d,p)^{41}Ca 2.47-MeV reaction was compared with a preliminary prediction of the distorted wave Born approximation. No agreement was found between the experimental results and this particular theoretical prediction. (Disser. Abstr.)

1850 A STUDY OF THE PRODUCTION AND DECAY OF ^{78}As. Maddison, David Wesley. Pullman, Wash., Washington State Univ., 1968.

Thesis.

A study of the decay of ^{78}As produced by a fast neutron reaction on ^{81}Br revealed the presence of 13 gamma rays and a half-life of 91.8 ± 0.4 minutes. Ten of the gamma ray energies were measured to ±1 keV with a lithium-drifted germanium detector. The beta decay was investigated with a lithium-drifted silicon detector. A decay energy of 3.75 MeV was established and was compared to values computed from recent semi-empirical mass equations. A value of 5 ± 1 millibarns was found for the ^{81}Br(n,α)^{78}As reaction cross section which compares with values of 10 millibarns and 100 millibarns reported by other investigators. A decay scheme is presented incorporating nine excited states in ^{78}Se. A spin and parity of 2^- were assigned to the ground state of ^{78}As and compared to predictions from a nuclear shell theory. (Disser. Abstr.)

1851 PARTIAL WAVE ANALYSES OF INELASTIC ELECTRON SCATTERING ON NUCLEI CONSIDERING FINITE ENERGY LOSS WITH APPLICATION TO THE GIANT RESONANCES OF MEDIUM AND HEAVY EVEN NUCLEI. Tuan, Shiang-tai. Durham, N. C., Duke Univ., 1967. 129p.

Thesis.

Partial-wave analysis of inelastic electron scattering from nuclei is treated by the use of Coulomb distorted electron wave functions; the calculation takes into account the non-zero energy loss. The results are compared both to the approximation in which the energy loss is neglected as well as to the Born approximation (in which a plane wave is taken). For the nuclear system the calculations employ a collective model, which treats the coupling of the giant dipole and quadrupole resonances. The transition charge and current (between the ground state and the collective resonance state) which is coupled to the electron motion in the inelastic electron scattering are derived and discussed. The partial-wave calculation is carried out explicitly to obtain the electron cross sections, which are functions of the scattering angle as well as function of the excitation energy. The results of these calculations admit of experimental verification (although to date there are 110 available experimental data). The calculations were done for the nuclei ^{50}Ti, ^{50}Cr, ^{58}Fe, ^{60}Ni, ^{76}Se, ^{90}Zr, ^{142}Nd, ^{196}Pt, and ^{198}Hg. (These nuclei are typical representatives of the special vibrational nuclei in the range $50 < A < 150$, $190 < A < 210$). These results are discussed in terms of the characteristics of the model. (Disser. Abstr.)

1852 PHOTONEUTRON CROSS SECTIONS ON NICKEL ISOTOPES. Goryachev, B. I.; Ishkhanov, B. S.; Kapitonov, I. M.; Piskarev, I. M.; Shevchenko, V. G.; Shevchenko, O. P. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.), 8: 46-52 (July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 76-8(July 20, 1968).

Effective photoneutron cross sections were measured for ^{58}Ni and ^{60}Ni in the γ energy range from 7.5 to 33.0 MeV, using BF_3 counters and a 64-channel system to obtain the yield curves. The results indicate that an important role is played by excitation of the internal nucleons in processes involving the emission of photoneutrons from either nucleus. (D.C.W.)

1853 THE THERMAL NEUTRON CROSS SECTION AND THE RESONANCE INTEGRAL OF ^{184}Os, ^{190}Os, ^{192}Os, ^{64}Zn, ^{68}Zn, AND ^{59}Co. Kim, J. I.; Adams, F. (Ghent Univ.). Radiochim. Acta, 9: 61-6(Aug. 1968).

By neutron activation measurement with a cadmium filter, using gold as a standard monitor, the thermal neutron cross sections and the resonance integrals of ^{184}Os, ^{190}Os, ^{192}Os, ^{64}Zn, and ^{59}Co were measured. A comparison technique was applied to measure, primarily, the effective cross sections. The thermal neutron cross sections and the resonance integrals were calculated from the knowledge of the cadmium ratio and the relative flux density of the epithermal neutrons at the irradiation site. (auth)

1854 MEASUREMENT OF THE LIFETIME OF THE 287-keV-LEVEL IN ^{75}Se. Richter, F. W.; Schuett, J.; Wiegandt, D. (Univ., Marburg, Ger.). Z. Phys., 217: 1-8(1968). (In German).

The nuclear half-life of the 287-keV second excited state of ^{75}Se, populated by the reaction ^{75}As(p,n)^{75}Se* was measured by the delayed coincidence technique. NaI(Tl) and Ge(Li) detectors were used for measuring γ-energies and time-spectra. By slope analysis of the time-spectra, a half-life of 30.0 ± 0.4 nanosec was obtained. Possible spin assignments for the 287-keV state in ^{75}Se from log ft values derived from β^+ decay data of ^{75}Br to this level by Baskova et al. are $3/2^-$ and $1/2^-$. Application of an external magnetic field of 24 kG to the target nuclei yielded no measurable perturbation of the time-spectra; thus, a spin value of $1/2^-$ for this level seems to be more probable. (auth)

1855 A STUDY OF ^{31}Si WITH ^{30}Si(d,p) ANGULAR DISTRIBUTION AND ^{30}Si(d,pγ) ANGULAR CORRELATION MEASUREMENTS. Webb, Virgil Harris. Durham, N. C., Duke Univ., 1968. 213p.

Thesis.

The 0.76^-, 1.70^-, 2.32^-, 2.79^-, 3.14^-, and 3.54-MeV levels of ^{31}Si were studied using an angular correlation technique which utilizes a collinear geometry with the observed particles being detected in an annular solid-state counter placed at 180° relative to the beam direction. The above levels were populated by the ^{30}Si(d,p)^{31}Si reaction with deuteron energies of 3.01 and 3.22 MeV. From the analysis of the experimental correlations, spin determinations of $5/2$, $3/2$, $1/2$, and $3/2$ were established for the 1.70-, 2.32-, 3.14-, and 3.54-MeV levels, respectively. An isotropic correlation was measured for the level at 760 keV in agreement with the known spin of $1/2$ for this level. The analysis for the 2.79-MeV level agrees with the spin values of $3/2$ and $5/2$ which are allowed by the $l_n = 2$ value from the ^{30}Si(d,p) reaction corresponding to population of this level. In addition, information on the gamma-ray multipole mixing ratios and gamma-ray branching ratios for many of the above levels was determined. ^{30}Si(d,p) absolute differential cross sections were measured at $E_d = 3.20$, 3.70, and 3.90 MeV corresponding to population of the ground ($Q_o = 4.367$ MeV) and first six excited levels (0.76, 1.70, 2.32, 2.79, 3.14, and 3.54 MeV) in the ^{31}Si residual nucleus. Yield curves were measured for the above proton groups at $\theta_{Lab} = 50°$ and for the scattered deuterons at $\theta_{Lab} = 50$ and 135° over the energy range 2.90 MeV $\lesssim E_d \lesssim$ 4.00 MeV. Distorted-wave Born approximation fits were made for the ^{30}Si(d,p) angular distributions with the entrance channel optical parameters being determined from optical model fits to ^{30}Si(d,d)^{30}Si angular distributions. From the analysis of the (d,p) cross sections, information on the orbital angular momenta, l_n, of the captured neutrons was obtained. The results indicate l_n values of 2, 0, (2), 2, 3, and 1 for the ground, 0.76-, 2.32-, 2.79-, 3.14-, and 3.54-MeV levels, respectively. However, the large anomalies observed in the yield curves project some doubt upon the spectroscopic factors which were extracted from the analysis. The predictions of a single-particle collective model for the low-lying levels of ^{31}Si are compared to the experimental results. Two rotational bands are identified corresponding to the Nilsson orbits 8 ($K = 3/2^+$) and 9 ($K = 1/2^+$) with the ground and first excited (760 keV) levels being the respective bandheads. The results indicate ^{31}Si is an oblate spheroid with a deformation on the order of $\eta \approx -2$. With the parameters of $\kappa \approx 0.10$, $g_R \approx 0.32$, and $\mu \approx 0.167$ the model is found to give reasonable results for many of the properties of the low-lying levels of ^{31}Si. In particular, the model is found to predict the anomalously high T(E2)/T(M1) multipole mixing ratio measured for the 1.70 to 0.0 MeV gamma-ray transition. (Disser. Abstr.)

1856 AN ANGULAR CORRELATION STUDY OF THE LOW LEVELS OF ^{27}Si. Lewis, Montague B. Durham, N. C., Duke Univ., 1967. 124p.

Thesis.

The low-lying excited levels of ^{27}Si were studied by the ^{28}Si(^{3}He,$\alpha\gamma$)^{27}Si reaction. The particle-gamma angular correlation method of Litherland and Ferguson was used. Most probable spin assignments for the 0.96-, 2.17-, and 2.65-MeV levels were determined as $5/2$, $7/2$, and $5/2$, respectively. Transitions from the 3.54- and 4.13-MeV levels appeared to have isotropic gamma ray angular correlations and decayed primarily through the well established $J = 1/2$ level at 0.78 MeV. A spin assignment of $1/2$ is likely for these two levels although a $J = 3/2$ assignment can not be rigorously ruled out. The branching scheme for the decay of the 3.80 MeV level suggests a spin of $3/2$ for this level although an angular correlation was not carried out. The gamma ray spectra for the doublet at 2.87 and 2.91 MeV indicate a strong ground-state transition for both levels. Mixing ratios and branching ratios for many of the gamma ray decays were measured

for the first nine levels. Strong and weak coupling model calculations were carried out and the results indicate significant evidence for ^{28}Si core excitation configuration in the ^{27}Si levels below 3.00 MeV. Many transition properties predicted by the strong coupling (rotational) model are in conflict with measured values. (Disser. Abstr.)

1857 STUDY OF THE GROUND-STATE ISOBARIC ANALOGUE RESONANCE IN ^{49}Sc AND OF THE LEVEL STRUCTURE OF ^{49}Sc BY THE ^{48}Ca(p,nγ) REACTION. Vingiani, G. G. (Istituto Nazionale di Fisica Nucleare, Naples); Ricci, R. A.; Giacomich, R.; Poiani, G. Nuovo Cim., 57B: 453-77(Oct. 11, 1968).

The ^{48}Ca(p,nγ)^{49}Sc reaction was investigated between 1.2 and 4 MeV proton bombarding energy at the 5.5 MV Van de Graaff accelerator of Padua University, with high energy resolution. The main features of the ground-state isobaric analogue resonance of ^{49}Sc were studied, measuring the γ-ray yield and spectra and the neutron decay with the time-of-flight technique. The ^{49}Ca ground-state analogue is split into several components whose decay properties were investigated. The total width of the major component at E_p = 1975 keV is about 2 keV, leading to a partial proton width Γ_p = 1.9 or 0.08 keV, the first one giving a spectroscopic factor quite near to the expected single-particle value; however part of the analogue strength should be shared among at least seven components giving a typical example where the $T_>$ analogue state dissolves into the surrounding $T_<$ states with the same spin and parity. The level structure of ^{49}Sc was studied fitting the γ-rays found at several bombarding energies into a level scheme up to an excitation energy of 3.14 MeV. The results are compared with other ^{48}Ca(p,nγ) and ^{48}Ca(p,n) reactions and a more complete decay scheme is proposed. Spin and parity assignments were made taking into account the γ decay data; the 2^- assignment is proposed for the 1402 keV level, which is assumed as arising from a $d_{\frac{3}{2}}$ proton-hole coupled to the $(f_{\frac{7}{2}})^{-1}$ neutron configuration. Moreover, the $(\pi f_{\frac{5}{2}})\ (\nu f_{\frac{5}{2}})^{-1}$ spectrum assumed on the basis of the present experimental data is compared with the $(\pi f_{\frac{5}{2}})\ (\nu f_{\frac{5}{2}})$ spectrum of ^{42}Sc via the particle-hole transformation. (auth)

1858 ELASTIC AND INELASTIC SCATTERING OF POLARIZED PROTONS AT 20 MeV FROM THE NUCLEI ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{27}Al, AND ^{28}Si. Vaganov, P. A. Vestn. Leningrad Univ., Ser. Fiz. Khim., No. 10, 41-55(May 1968). (In Russian).

With the new type of injection for the Saclay cyclotron, the asymmetry in the elastic and inelastic scattering of 20-MeV polarized protons was studied for the nuclei ^{24}Mg, ^{25}Mg, ^{26}Mg, ^{27}Al, ^{28}Si. Good optical model fits were obtained to the elastic polarization and cross-section data, but there is no single set of geometrical parameters for these nuclei. The radius of the spin-orbit potential was smaller by about 10% than that of the central potential. DWBA calculations were performed on the inelastic polarization data (l = 2 transitions). In general, these fits are unsatisfactory, though for the backward hemisphere the form of the experimental peak in the asymmetry distribution is reproduced. (auth)

1859 SHELL-MODEL STUDIES OF 1F, 2P-SHELL NUCLEI. 4. POSSIBLE ENERGY LEVELS OF ^{44}Ti. Nagai, Hiroyuki (Kyushu Inst. of Tech., Japan); Yamaji, Yoshimi Bull. Kyushu Inst. Technol., Math., Natur. Sci., No. 15, 25-35(Mar. 1968).

The level scheme of the ^{44}Ti nucleus with four nucleons in the 1f2p-shell outside the double closed-shell ^{40}Ca core was studied by the use of the harmonic-oscillator shell model. A central interaction potential with a Yukawa shape and Rosenfeld mixture was assumed as the residual interaction. Only those ^{11}L states which are of the most symmetric [4] type were considered. In particular, the dependence of level orders and spacings on admixture of configurations which are taken into account successively was investigated. Consequently, it turns out that low-lying states show a rotational spectrum when all configurations belonging to the 1f2p-shell are taken into account. (NSA of Japan)

1860 ANALYSIS OF THE FAST NEUTRON CROSS SECTION OF IRON. Chien, J. P. (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Peking)(Engl. Transl.), 6: 15-24(Apr. 1968).

The resonance peaks of the total cross section of iron were analyzed by single-level or multi-level formulas for neutron energies from 0.5 MeV to 1.5 MeV. The resonance parameters and the quantum states of the compound nucleus were suggested. The statistical distributions of the level widths and level spacings were compared with theories. The differential cross sections were interpreted by the optical model. (auth)

1861 GAMMA-RAY ENERGY, BRANCHING RATIO, AND LIFETIME MEASUREMENTS IN ^{40}Ca. Dolan, Kenneth William. Eugene, Oreg., Univ. of Oregon, 1968. 149p.

Gamma-ray decay modes of ^{40}Ca states below an excitation energy of 10 MeV were investigated by the ^{39}K(p,γ)^{40}Ca reaction using a 20-cm^3 lithium-drifted germanium, Ge(Li), detector. Gamma-ray spectra were obtained at 0, 55, 90, and 120° with respect to the incident proton beam using 8- to 20-keV thick targets of natural KI and K_2SO_4 evaporated on gold backings. Resonance spectra were recorded at proton energies of 1.344, 1.374, 1.486, 1.563, and 1.666 MeV. A gamma-ray energy calibration technique of recording the known ^{56}Co spectrum simultaneously with the unknown resonance spectra was used to obtain energy measurements to an accuracy of 0.1% for gamma-ray energies between 0.5 and 3.3 MeV. From these measurements, a more precise value of the reaction-Q of 8.3295 ± 0.0012-MeV was obtained from the cascaded gamma-ray transition energies and the incident proton energy at the 1.374-MeV resonance. Accurate measurements of gamma-ray transition energies allowed unambiguous identification of all the levels populated through the (p,γ) reaction with levels observed in particle reaction studies. The decay modes of the E_p = 1.486-MeV resonance level includes decays to the 7.561-MeV level rather than to the 7.46-MeV level as previously conjectured, to both members of the 5.62-MeV doublet rather than to only one member, and to the known level at 5.278-MeV. In addition to the previously observed decay modes of the E_p = 1.374-MeV resonance level, the proposed decay scheme includes transitions to levels at 7.534 and 7.240 MeV also known from particle reaction studies. No transition was observed to the 7.69-MeV level as previously reported. The gamma-ray decay modes of levels not previously observed in gamma-ray studies are proposed for the ^{40}Ca excited states at 7.240, 7.534, 7.561, and 8.271 MeV. New branchings of the J = 3 7.113-MeV level to the $J^\pi = 4^-$ 5.613-MeV and the $J^\pi = 2^+$ 3.904-MeV levels were observed with branching ratios of 16% and 23%, respectively. An upper limit on the branching of the 3.904-MeV (2^+) level to the 3.353-MeV (0^+) level is set at 1%. The mean lifetimes of levels at 3.904, 5.613, 6.285, 7.465, and 7.561 MeV are inferred from Doppler shift attenuation measurements to be 0.77 ± 0.18, 2.6 > 5, 4.5, 0.30, and 3.0×10^{-13} seconds. An analysis of this method for measuring lifetimes using the low momentum transfer (p,γ) reaction is given. It is shown that lifetimes measured by this technique agree within error to those measured by higher momentum transfer reactions. A comparison of the branching ratio and lifetime measurements reported here is made with recent particle-hole calculations. The existence of a positive parity rotational band is confirmed by the measured 5.278-MeV (4^+) to 3.904-MeV (2^+) in-band transition probability. (Diss. Abstr.)

1862 RADIATIVE ALPHA CAPTURE IN ^{20}Ne. Highland, George James. University Park, Pa., Pennsylvania State Univ., 1967. 88p.

The radiative capture reaction, ^{20}Ne(α,γ)^{24}Mg was studied in the region E_α = 3 to 6 MeV using ^{20}Ne targets (embedded in niobium or tantalum backings) prepared directly in isotope separators. At least 21 resonances observed were attributed to the ^{20}Ne(α,γ)^{24}Mg reaction. Only natural-parity states could be observed: i.e., J^π = 0^+, 1^-, 2^+, 3^-, 4^+. Angular distributions performed at the stronger resonances determined the spin and parity in the case of ground-state transitions and restricted the possible spin values for those states which decay primarily by γ_1 radiation. The partial resonance strengths $\omega\gamma_0$, $\omega\gamma_1$, $\omega\gamma_{2,3}$, and $|M|^2$ values were determined. The $|M|^2$ values found in the present investigation, with the exception of a strong (T = 1?) 1^- resonance at E_α = 5.653 MeV, fit well with Van der Leun's survey of the distribution of gamma transition probabilities in the A = 20 to 40 nuclei. Six resonances, which were found in this investigation, appeared to have corresponding resonances seen in the ^{20}Ne(α,α)^{20}Ne reaction. At least 12 resonances appear to have corresponding proton resonances, and the number would probably be greater if it were not for the shortage of proton data above 1.5 MeV and total lack above 2.5-MeV proton energy. The identification of corresponding resonances was made by a detailed study of the resonance parameters, which included comparisons of spin and parity assignments and/or strongly similar decay schemes; while in other cases it was limited to energy coincidences. A search was conducted for possible 5^-, 6^+, and 8^+ states observed in the ^{12}C(^{16}O,α)^{24}Mg*(α)^{20}Ne reaction. One (or possibly both) of a pair of resonances at 5.720 and 5.743 MeV appears to be 6^+; the resonance at 5.796 appears to be 5^-. A $(\gamma_2 + \gamma_3)$ gate, 1.5 MeV wide, was employed in the coincidence experiments at 5.720, 5.743, and 5.796 MeV, in order to determine the main decay features of these resonances. The 5.720- and 5.796-MeV resonances appear to decay primarily to the 4^+ state at 4.12 MeV, suggesting the possibility of large initial spin values, J ≥ 5. The γ_2 angular distribution of the 5.720 MeV resonance was consistent with the $6^+ \rightarrow 4^+$ theoretical angular distribution. An estimate of the resonance strength for an $8^+ \rightarrow 6^+$, ΔK = 0 transition, indicated that the transition gamma rays might be observable. The search yielded a negative result. However, in view of the large error in the stated excitation energy, the negative result is not believed to be conclusive evidence for abandoning the search. (Diss. Abstr.)

1863 RADIATIVE CAPTURE IN NICKEL AND BISMUTH OF NEUTRONS IN THE MeV REGION. Bergqvist, I. (Research Inst. of National Defence, Stockholm); Lundberg, B.; Nilsson, L.; Starfelt, N. Nucl. Phys., A120: 161-82(1968).

Gamma-ray spectra from neutron capture in nickel in the energy range 0.9 to 8.3 MeV and in bismuth in the energy range 4.7 to 8.3 MeV were recorded. The gamma-ray spectrometer was a NaI(Tl) crystal, 20.8 cm long and 22.6 cm in diam. Time-of-flight techniques were used to improve on the signal-to-background ratio. Cross sections were evaluated for high-energy gamma-ray transitions from the capturing state to low-lying states in the residual nuclei. The comparison between these cross sections and calculations based on semi-direct capture theories shows that the semi-direct capture processes are important to explain the magnitude and energy variation of the neutron capture cross section in the region of the electric dipole giant resonance. (auth)

1864 LEVELS IN ^{89}Y POPULATED BY DECAY OF ^{89}Zr. Draper, James E.; McCray, James A. (Univ. of California, Davis). Nucl. Phys., A120: 234-40(1968).

Gamma spectra resulting from the decay of ^{89}Zr were measured and were used to obtain the level scheme of ^{89}Y. The ^{89}Y target was bombarded with ≈10 MeV protons. Transitions assigned to ^{89}Y are 908, 1506, 1617, 1655, 1712, and 1744 keV. Energy levels of ^{89}Y are assigned as 908, 1506, 1744, 2525, 2563, and 2620 keV. (auth)

1865 SEARCH FOR TIME-REVERSAL NON INVARIANCE IN STRONG INTERACTIONS. Kajfosz, J.; Kopecky, J.; Honzatko, J. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys., A120: 225-33(1968).

A TRI-test by means of angular correlation measurements of a gamma-ray cascade from polarized thermal neutron capture in ^{49}Ti was carried out. The results provide an upper limit of 2.5% for the time non-invariant admixture in the effective Hamiltonian. (auth)

1866 keV NEUTRON CAPTURE IN IRON. Bird, J. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales. Oak Ridge National Lab., Tenn.). Nucl. Phys., A120: 113-25(1968).

Gamma-ray intensities are given for capture of 15 to 80 keV neutrons in ^{54}Fe, ^{56}Fe, and natural iron and for their variation with neutron energy. The results show a correlation with thermal capture and (d,p) results for low-lying final states in ^{55}Fe and ^{57}Fe, thus suggesting that there is a considerable overlap of the configurations of the capturing and final states. However, reduced widths are not as large as would be expected for single-particle transitions. Limited evidence is observed of an anti-correlation between (d,p) and capture results, and the explanation in terms of possible doorway states can only apply to a small number of transitions. The observation of transitions to $^5/_2^-$ and $^7/_2^-$ final states is used to obtain evidence on the location of d-wave resonances in both ^{54}Fe and ^{56}Fe. Information on the isotopic allocation of resonances is also contained in the neutron energy spectra. (auth)

1867 DEUTERON-INDUCED REACTIONS ON ^{28}Si. Gurd, D. P.; Roy, G.; Leighton, H. G. (Univ. of Alberta, Edmonton). Nucl. Phys., A120: 94-112(1968).

Absolute cross sections for the elastic scattering reaction ^{28}Si(d,d)^{28}Si were measured from 25 to 140° at six energies in the range E_d = 4.74 to 5.26 MeV. The distribution of protons from the l_n = 0 reaction ^{28}Si(d,p)^{29}Si$_{g.s.}$ and the l_n = 2 reactions ^{28}Si(d,p)^{29}Si* 1.28 and 2.03 was obtained at E_d = 5.0 MeV as well as the polarization of the ground state proton group. These data were compared with predictions of DWBA theory using deuteron optical-model parameter sets obtained by fitting the elastic distributions. The theory is unable to explain the polarization data, but some of the deuteron potentials provide fair agreement with the measured stripping distributions. Spectroscopic factors were extracted and compared with the predictions of the Nilsson model for ^{29}Si. (auth)

1868 INELASTIC ELECTRON SCATTERING STUDIES FROM ^{40}Ca AND ^{48}Ca. Zimmerman, P. D.; Yearian, M. R.; Donnelly, T. W. (Stanford Univ., Calif.). Contract Nonr 225(67); F44620-68-C-0075. Phys. Rev. Lett., 21: 1392-3(Nov. 4, 1968).

Inelastic electron scattering experiments from ^{40}Ca and ^{48}Ca at 282.8-MeV incident energy indicate the presence of sharp rises in cross section corresponding to the thresholds of the states ^{39}Ca + n and ^{47}Ca + n. (auth)

1869 NEUTRON ACTIVATION RESONANCE INTEGRALS OF ^{74}Se, ^{78}Se, ^{80}Se, ^{81}Br, ^{127}I, ^{130}Te, ^{138}Ba, ^{140}Ce, AND ^{142}Ce. Ricabarra, M. D.; Turjanski, R.; Ricabarra, G. H.; Bigham, C. B. (Comision Nacional de Energia Atomica, Buenos Aires). Can. J. Phys., 46: 2473-84(Nov. 15, 1968).

A lithium-drift germanium γ spectrometer was used to make accurate intercomparisons of the ratio of resonance integral to thermal activation cross section by measuring cadmium ratios or relative activation rates in two different neutron spectra. The standard, Au, or secondary standard, In, was mixed uniformly in the samples and the activities resolved with the spectrometer. Expressed as Westcott s_0 values, the results relative to s_0 = 17.7 for Au were as follows: ^{74}Se = 10.3 ± 0.1, ^{78}Se = 12.3 ± 0.3, ^{80}Se = 2.65 = ±0.02, ^{81}Br = 24.3 = 0.5, ^{127}I = 27.8 ± 0.5, ^{130}Te = 2.10 ± 0.07, ^{138}Ba = 0.649 ± 0.004, ^{140}Ce = 0.476 ± 0.003, ^{142}Ce = 0.865 ± 0.005. (auth)(CANADA)

1870 DECAY OF ^{70}Se. Boswell, G. G. J.; McGee, T. (Univ. of Salford, Lancashire, Eng.). J. Inorg. Nucl. Chem., 30: 2571-6(Oct. 1968).

^{70}Se was produced by the ^{59}Co(^{14}N,3n)^{70}Se reaction using 140-MeV nitrogen ions on natural cobalt foil. The mass assignment of ^{70}Se was fixed by identification of the ^{70}As daughter activity which was found to have a half-life of 52.5 ± 0.3 min. The half-life of ^{70}Se was found to be 8.9 ± 1.1 min from a determination of the yields of ^{70}As activities. Gamma rays of energies 0.021, 0.032, 0.050, 0.113, 0.134, 0.203, 0.243, 0.291, 0.377, 0.415, and 0.427 MeV were observed in the decay of ^{70}Se using a lithium-drifted germanium detector. (auth)(UK)

1871 INVESTIGATION OF THE ^{41}K(p,α)^{38}Ar REACTION AT 7.5-MeV BOMBARDING ENERGY. Graue, Arnfinn; Herland, Lars (univ. of Bergen). Arb. Univ. Bergen, Mat.-Natur. Ser., No. 2(1966).

The reaction ^{41}K(p,α)^{38}Ar was studied using 7.5-MeV protons. A broad-range magnetic spectrograph was used in the detection of the emitted alpha particles. 24 excited states in ^{38}Ar up to 6.3 MeV excitation energy were observed. The ground state Q-value was measured to be Q_0 = 4.018 ± 0.015 MeV. (auth) (Norway)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 677, 681, 1765, 1767, 1825, 1833, 1837, 1839, 1846, 1851, 1853, 1863, 1869, 1929, 1936–1938, 1953, 1955, 1961, and 1964.

1872 (AD–671932) STUDY OF THE INTERNAL CONVERSION ELECTRONS FROM THE DECAY OF ^{147}Nd TO ^{147}Pm. Danber, Edward B. (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). May 1968. 97p. (GNE/PH-68-6). CFSTI.

Thesis.

Sources of ^{147}Nd were produced by neutron irradiation of ^{146}Nd deposited by vacuum sublimation onto aluminum foil backings. The internal conversion electron spectrum was studied with an iron-core 50.5-cm radium beta-ray spectrometer. The transition energies (in keV) were 91.04 ± 0.05, 120.44 ± 0.05, 196.67 ± 0.08, 275.46 ± 0.08, 319.45 ± 0.09, 398.04 ± 0.09, 410.33 ± 0.29, 439.78 ± 0.09, 530.92 ± 0.08, 589.03 ± 0.12, 594.59 ± 0.12, and 685.78 ± 0.07. The 489 K line was observed, but the energy could not be accurately determined. Internal conversion coefficients were determined with the aid of relative gamma-ray intensities from other experiments. Possible multipolarity assignments were made. (auth)

1873 (BNL-tr–222) NEUTRON RESONANCES OF THE GADOLINIUM ISOTOPES. Karzhavina, E. N.; Phong, N. N.; Popov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P3-3882. 27p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 42014. (auth)

1874 (CEA-R–3500) SPECTROSCOPIC STUDY OF $^{206\ 207\ 208}$Pb ISOTOPES BY HIGH RESOLUTION ANALYSIS OF 24.5 MeV PROTON SCATTERING. Vallois, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1968. 123p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

^{206}Pb, ^{207}Pb, and ^{208}Pb were studied by 24.5-MeV proton inelastic scattering with a resolution of 20 keV. The angular distributions of the differential cross sections corresponding to the different excited levels were measured in a large angular region and were analyzed with the DWBA. Between 4 and 5 MeV of excitation energy there exist some strongly excited levels corresponding to transfer momenta l = 2, 4, 6, and 8. The single particle-hole models do not explain these states; so it will probably be necessary to introduce several particle-hole configurations. (auth)

1875 (INP–620) LEVEL SCHEME OF ^{147}Sm AND g-FACTORS OF ITS TWO LOWEST EXCITED STATES. Bozek,

E.; Broda, R.; Golczewski, J.; Hrynkiewicz, A. Z.; Kulessa, R.; Niewodniczanski, H.; Rybicka, M.; Walus, W. (Institute of Nuclear Physics, Krakow (Poland)). July 1968. 16p. Dep.

The level scheme of ^{147}Sm was investigated by the $\gamma-\gamma$ coincidence method. New levels at 1200, 1300, and 1395 keV were deduced. The existence of the 1180 and 1228-keV levels, tentatively introduced in previous papers, is questioned. The lifetimes of the 122- and 198-keV states were remeasured as: τ(122 keV) = 1.15 ± 0.06 ns and τ(198 keV) = 1.95 ± 0.15 ns. The g-factors of the 122- and 198-keV states were determined by observing the integral rotation of the angular correlations in an external magnetic field. The results g(122) = −0.12 ± 0.07 and g(198) = −0.19 ± 0.07 are compared with theoretical predictions based on the calculations of Kisslinger and Sorensen. (auth)

1876 (JINR-E4-4029) SHELL MODEL CALCULATIONS FOR ^{211}Bi. Gabrakov, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. Dep.

Shell-model calculations of the energies of the first several levels in ^{211}Bi with spins $^9/_2$ and $^7/_2$ were made. The log ft-values for beta-decay to these levels and the probabilities for E2 and M1 transitions were also calculated. (auth)

1877 (NP-17644) MEASUREMENT OF AVERAGE NEUTRON CAPTURE CROSS-SECTIONS IN THE MASS REGION ABOVE 100. Moxon, Michael Charles (Atomic Energy Research Establishment, Harwell (England)). July 1968. 85p. Dep. CFSTI. UK.

Thesis. Submitted to London Univ., England.

A γ-ray detector was developed to measure neutron capture cross sections in the energy range up to 100 keV. The effect on the efficiency for detecting a neutron capture event of variations in the γ-ray cascade scheme following the event are minimized by having an efficiency proportional to the total γ-ray energy emitted The effect of the scattered neutrons could be ignored in the measurements reported, as the efficiency for detecting them is low ($\sim 1.5 \times 10^{-4}$ of that for a capture event). Measurements of the capture cross sections were made on the Harwell linear accelerator neutron time-of-flight spectrometer using a 32.5-m flight path giving a nominal timing resolution of 8 ns/m. The values of the capture cross sections for the following nuclei are given: ^{103}Rh, In, ^{116}Sn, ^{117}Sn, ^{119}Sn, ^{120}Sn, ^{122}Sn, ^{124}Sn, ^{165}Ho, ^{181}Ta, ^{197}Au, ^{Nat}Pb, ^{232}Th, and ^{238}U. The neutron strength functions and the ratio of the average radiation width divided by the level spacing were determined from fits to the measured data. The results for the average parameters are in reasonable agreement with the values determined from total cross-section data. This contrasts with the previous interpretation of capture cross-section data in certain mass regions (e.g., mass near A = 100) and may be due to the fact that these measurements were made down to an energy of 1 keV whereas previous data were in an energy region above 10 keV, where the cross section does not depend a great deal on the p-wave strength function. (auth) (UK)

1878 (NYO-2028-3) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Sept. 1968. 184p. Dep. CFSTI.

Studies of the nuclear moments of several rare-earth isotopes were carried out. Accurate values for the magnetic moments of isotopes of Dy and Er were obtained. These values indicate that the present form of the collective model for even-even nuclei is unable to provide close agreement with measured moment values. Work is continuing on the moments of ^{238}U. Much larger Moessbauer effects were observed for this isotope. Other Moessbauer effect experiments were carried out using radioactive sources. Effects were observed in ^{148}Nd. Magnetic studies were carried out on $FeCO_3$. Magnetostrictive side-band effects were observed in iron foils subject to rf magnetic fields. Studies of the ferroelectric transitions in some iron-containing compounds were made. High-temperature studies of the Moessbauer effect in ^{57}Fe have given added information about the behavior of the recoilless fraction, f, and the isomer shift at first-order phase transitions. For the nuclear reactions program, a long series of experiments studying the behavior of polarized nuclei in metals with cubic structure were finished. These involved low-field precession techniques and high-field resonant depolarization techniques to measure the moment of ^{12}B. Systematic corrections to these results due to the Knight shift and weak quadrupole interactions had to be made. These effects were determined by making a series of studies of the relaxation times T_1 and T_2 as a function of magnetic field and absolute temperature. The main result of these investigations with ^{12}B indicates that it is possible to obtain a very high accuracy in the determination of moments of certain rather important radioactive nuclei using these techniques. A velocity drive system was added to the helium gas flow cryostat, and a liquid nitrogen flow cryostat was developed. A thin planar Ge(Li) detector was found to be sensitive to linearly polarized γ rays when they are incident in the plane of the detector. (D.C.W.)

1879 (ORNL-4306, pp 1-21) NUCLEAR CHEMISTRY. (Oak Ridge National Lab., Tenn.).

The neutron capture resonance integral of ^{237}U was measured, as were the (n,2n) cross sections of ^{237}Np, ^{233}U, and ^{235}U. The thermal neutron capture cross sections and resonance integrals of ^{93}Nb and ^{94}Nb were determined. The reactor cross section of ^{204}Tl was measured; a remeasurement of the thermal cross section and resonance integral of ^{203}Tl was made. The mixing of collective bands in ^{154}Gd and ^{152}Sm was investigated using the decays of ^{154}Eu and ^{152}Eu. The decays of the isomers ^{80}Br, ^{110}In, ^{89}Nb, and ^{89}Zr were also studied. The decay of ^{158}Eu was used to study the energy levels of ^{158}Gd. The new isotope ^{135}Nd, which decays by β^+ emission to ^{135}Pr, was identified; and levels in ^{135}Ce were investigated through the decay of ^{135}Pr. The energy levels of ^{92}Nb, ^{94}Nb, ^{94}Tc, ^{95}Tc, ^{96}Tc, ^{97}Tc, and ^{98}Tc were studied using (p,nγ) reactions. Fission-fragment mass vs energy correlations in the fission of ^{233}U, ^{235}U, and ^{238}U by 7- to 13-MeV protons and in the fission of ^{232}Th by 30-MeV protons were investigated. A prototype low-background γ spectrometer for geochemical assay of lunar samples was completed. (D.C.W.)

1880 (ORNL-4306, pp 22-45) CHEMISTRY AND PHYSICS OF TRANSURANIUM ELEMENTS. (Oak Ridge National Lab., Tenn.).

The α decay of ^{253}Cf, ^{254}Cf, ^{229}Np, ^{230}Np, ^{242}Pu, and ^{244}Pu was investigated, as was the β and/or electron-capture decay of ^{245}Am, ^{172}Hf, ^{172}Lu, and ^{245}Pu. The decay studies yielded information on the level structure of some of the daughter nuclei. A search for the nuclide ^{247}Pu was conducted. Deuteron energy spectra from the reaction ^{238}U(^{3}He,d)^{239}Np were measured, as was the angular distribution of ^{64}Cu nuclei from the reaction ^{65}Cu(^{3}He,α)^{64}Cu. The independent yield of ^{134}I and the mass yields of ^{101}Mo and ^{102}Mo from the spontaneous fission of ^{252}Cf were investigated. A search for ^{101}Nb from thermal neutron fission of ^{235}U was conducted. The thermal neutron capture cross section and resonance integral of ^{252}Cf were measured. A gas-jet system for the rapid collection of recoil nuclei was developed, and the construction of the $\pi\sqrt{2}$ double-focusing electron spectrometer was essentially completed. Intramolecular energy transfer in actinide β-diketones was investigated, as were charge-transfer spectra of actinide and lanthanide trihalides in solution and self-activated thermoluminescence in actinide- and lanthanide-doped ThO_2 crystals. CfOF was prepared, and its crystal structure was studied. The crystal and molecular structure of Cs tetrakishexafluoroacetyl-acetonato-europate(III) and -americate(III) was investigated, as were the properties of some rare-earth and Am chelates. (D.C.W.)

1881 (ORNL-TM-2364) REPORT TO THE AEC NUCLEAR CROSS SECTION ADVISORY COMMITTEE. Stelson, P. H. (Oak Ridge National Lab., Tenn.). Sept. 1968. Contract W-7405-eng-26. 24p. Dep. CFSTI.

Several investigations of charged-particle reactions and scattering and of neutron reactions and scattering are summarized. Information on the energy levels and neutron resonance parameters of some isotopes is presented. In addition, the interactions of heavy ions with gases and solids, neutron spectra in the upper atmosphere, photonuclear cascades, neutron fluxes from reactions of GeV protons, and the Moessbauer effect for ^{61}Ni in Cu−Ni alloys were investigated. A test of time reversal invariance by spin-flip in proton elastic scattering by ^{13}C is reported, as are developments in the preparation of C foils, ^{152}Eu targets, and ^{238}Pu samples. (D.C.W.)

1882 (WASH-1093) REPORTS TO THE AEC NUCLEAR CROSS SECTIONS ADVISORY COMMITTEE. Meeting Held at Los Alamos, New Mexico, April 3–4, 1968. Moore, M. S. (comp.) (Nuclear Cross Sections Advisory Committee (AEC)). 186p. (EANDC(US)-105-U; INDC(US)-2-U). Dep. CFSTI.

Numerous experimental investigations of neutron reactions and scattering, charged-particle reactions and scattering, and photonuclear reactions are summarized. Developments in techniques for analyzing nuclear reactions and cross-section data are outlined. Many of the studies yielded information on nuclear energy levels. Developments in experimental equipment and data processing techniques are also reported. (D.C.W.)

1883 THE (γ,p) AND (γ,n) REACTIONS IN MOLYBDENUM. Gellie, R. W. (Univ. of Melbourne). Aust. J. Phys., 21: 765-8 (Oct. 1968).

The cross sections for some (γ,n) and (γ,p) reactions in Mo were measured using the technique of residual activation analysis. The gross structure of the cross sections was compared with previous measurements, and the results were interpreted as evidence for the isospin splitting of the giant dipole resonance in medium-weight nuclei. (D.C.W.)

1884 g-FACTORS AND MIXING RATIOS IN ^{156}Gd. Weitsch, A.; Walter, H. K. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 216: 459-71(1968). (In German).

By the method of integral perturbed γ-γ angular correlations, the gyromagnetic ratios of a 2-quasi-particle state at 1,513 keV and the 4^+ state of the ground-state rotational band in ^{156}Gd were measured, using sources prepared by ^{159}Tb(γ,3n) and ^{156}Gd(d,2n) reactions. In addition, the multipole mixing ratios were obtained for the 535-keV and 1,225-keV γ rays. The classification of the 1,513-keV state is discussed. The internal field of Gd in Tb metal at 77°K was found to be H = −192 ± 16 kOe. (auth)

1885 NEW ISOTOPES, ^{19}N AND ^{21}O, PRODUCED IN HIGH-ENERGY NUCLEAR REACTIONS. Thomas, T. D.; Raisbeck, G. M.; Boerstling, P.; Garvey, G. T.; Lynch, R. P. (Princeton Univ., N. J.). Phys. Lett., 27B: 504-6(Sept. 16, 1968).

Two new isotopes, ^{19}N and ^{21}O, were produced when gold was irradiated with 3 GeV protons. (auth)

1886 MASS DISTRIBUTION IN THE REACTOR NEUTRON FISSION OF ^{231}Pa AND ^{237}Np. Namboodiri, M. N.; Ravindran, N.; Rajagopalan, M.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Trombay, India). J. Inorg. Nucl. Chem., 30: 2305-10 (Sept. 1968).

Reactor neutron-induced fission of ^{231}Pa and ^{237}Np was investigated using radiochemical techniques employing the comparison method. Fission yields of more than 20 nuclides were obtained, and it was found that the mass-yield curves do not show any indication of a third peak in the symmetric region. The mass distribution obtained in both cases was compared with recent semiconductor data of primary distribution. The data in the fission of ^{237}Np were found to be in fair agreement with literature data. (auth) (UK)

1887 THE MUONIC X RAYS OF ^{107}Ag AND ^{109}Ag. Carrigan, R. A. Jr. (Carnegie-Mellon Univ., Pittsburgh); Gupta, P. D.; Sutton, R. B.; Suzuki, M. N.; Thompson, A. C.; Cote, R. E.; Prestwich, W. V.; Gaigalas, A. K.; Raboy, S. Phys. Lett., 27B: 622-24(Oct. 14, 1968).

The muonic x rays of ^{107}Ag and ^{109}Ag were observed, and the isotope shift of the K lines was measured. Adequate agreement is found between the change of the RMS radius obtained from muonic x rays and from optical spectroscopy. (auth)

1888 LEVELS IN ^{137}Cs, ^{139}La, ^{143}Pm, AND ^{145}Eu OBSERVED WITH PROTON TRANSFER REACTIONS. Wildenthal, B. H.; Newman, E.; Auble, R. L. (Oak Ridge National Lab., Tenn.). Phys. Lett., 27B: 628-30(Oct. 14, 1968).

Levels in the N = 82 nuclei ^{137}Cs, ^{139}La, ^{143}Pm, and ^{145}Eu were studied with the (d,^{3}He) and (^{3}He,d) reactions on ^{138}Ba and ^{144}Sm at an incident energy of 40 MeV. (auth)

1889 COULOMB DISPLACEMENT ENERGIES FROM ISOBARIC ANALOGUE STATE STUDIES IN DEFORMED NUCLEI. Cassagnou, Y.; Foissel, P.; Gastebois, J.; Levi, C.; Mittig, W.; Papineau, L. (CEN, Saclay, France). Phys. Lett., 27B: 631-2(Oct. 14, 1968).

Coulomb displacement energies for isobaric analogue states of some low-lying states of the deformed nuclei ^{171}Yb, ^{173}Yb, ^{175}Yb, and ^{177}Yb deduced from the analysis of the excitation functions determined by elastic scattering of protons are found lower than the displacements calculated with the usual formulas. This effect is attributed to the deformation of the nucleus. (auth)

1890 THE REORIENTATION EFFECT IN ^{114}Cd. Simpson, J. J.; Smilansky, U.; Wurm, J. P. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 27B: 633-5(Oct. 14, 1968).

Cross section measurements for scattering of ^{4}He and ^{16}O ions from ^{114}Cd were found consistent with a zero static quadrupole moment of the 0.558 MeV 2^+ state. (auth)

1891 RANGES OF FISSION FRAGMENTS FROM NEUTRON-INDUCED FISSION OF ^{241}Am. Ramaniah, M. V.; Rao, C. L.; Iyer, R. S.; Rajkishore; Laul, J. C. (Bhabha Atomic Research Centre, Trombay, India). pp 186-91 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The ranges of fission-product recoils in aluminium from the neutron-induced fission of ^{241}Am were measured using the thin target-thick catcher foil method. Targets of about 100 μg/cm^2 ^{241}Am were prepared on platinum backing by electrodeposition. Aluminium catcher foils of 0.3 mil thickness were placed above the target, and the target catcher assembly wrapped in aluminium foil was irradiated in CIRUS reactor. Several fission products were separated from the catcher foils, radiochemically purified and their activities measured. The ranges in aluminium were calculated from the activity distribution of the nuclides in the catcher foils applying scattering corrections for the platinum backing. (auth)

1892 RANGES OF FISSION FRAGMENTS IN REACTOR NEUTRON INDUCED FISSION OF ^{232}Th. Ramaniah, M. V.; Rao, C. L.; Jain, H. C.; Prakash, Satya; Manohar, S. B. (Bhabha Atomic Research Centre, Trombay, India). pp 192-6 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

A study of the fission fragment ranges in the neutron fission of ^{232}Th was undertaken. Assemblies of two-mil-thick thorium foils sandwiched between one-mil superpure aluminium foils were irradiated with reactor neutrons at Apsara reactor. Radiochemical methods were employed to isolate the activities in aluminium and thorium foils of some medium light and medium heavy fragments. From these data, ranges of the fission fragments were calculated. (auth)

1893 YIELDS OF SOME RARE EARTH NUCLIDES IN THE NEUTRON FISSION OF ^{231}Pa AND ^{237}Np. Namboodiri, M. N.; Ravindran, N. (Bhabha Atomic Research Centre, Trombay, India). pp 197-204 of Proceedings of the Nuclear and Radiation Chemistry Symposium, Poona, March 6-9, 1967. Bombay, Department of Atomic Energy, 1967.

See CONF-670335.

The relative yields of some rare-earth nuclides in the neutron-induced fission of ^{231}Pa and ^{237}Np were measured using radiochemical techniques. Cation exchange techniques were employed for the separation of individual rare earths. The measured values make it possible to draw the heavy wings of the mass-yield curves accurately. The variation of the yields in the heavy wings in the fission of several target nuclei is compared and discussed. (auth)

1894 ANHARMONIC EFFECTS IN NUCLEI OF THE TRANSITION REGION. Jolos, R. V.; Finer, U. M.; Soloviev, V. G.; Zheleznova, K. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 27B: 614-15(Oct. 14, 1968).

The admixtures of the two-phonon states to the lowest one-phonon states in some even-even nuclei of the transition regions have been considered. It was shown that these admixtures are not large but they increase when approaching spherical nuclei. (auth)

1895 THE DECAY OF ^{160}Tb TO LEVELS IN ^{160}Dy. Ludington, M. A. (Univ. of Michigan, Ann Arbor); Reidy, J. J.; Wiedenbeck, M. L.; McMillan, D. J.; Hamilton, J. H.; Pinajian, J. J. Nucl. Phys., A119: 398-416(1968).

The gamma radiation associated with the beta decay of ^{160}Tb to levels in ^{160}Dy was studied with curved-crystal and Ge(Li) spectrometers. Eight previously unreported transitions were observed with energies 237.638 ± 0.086 keV, 242.5 ± 0.8 keV, 246.489 ± 0.016 keV, 349.94 ± 0.11 keV, 432.7 ± 0.6 keV, 1005 ± 1 keV, 1069.1 ± 0.4 keV and 1300.0 ± 0.8 keV. The existence of transitions at 176, 379, 486, 872 and 1286 keV was confirmed. Gamma–gamma coincidence studies employing two Ge(Li) detectors led to a decay scheme which is essentially that given by previous investigators with the addition of levels at 1155.8, 1288.7 and 1535.2 keV. The level at 1155.8 keV was identified as the 4^+ member of the gamma-vibrational band. No evidence was obtained for the population of any $K^\pi = 0^+$ beta-vibrational levels from the decay of ^{160}Tb. (auth)

1896 A MASS SPECTROMETRIC DETERMINATION OF THE ELECTRON CAPTURE TO ELECTRON EMISSION RATIO OF ^{170}Tm AND THE REACTOR NEUTRON CROSS-SECTIONS OF ^{169}Tm, ^{170}Tm, AND ^{171}Tm. Crocker, I. H.; Werner, R. D.; Cherrin, W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 955-62 of Advances in Mass Spectrometry. Vol. 4. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968.

From 4th International Conference on Mass Spectroscopy, Berlin. See CONF-670920.

The concentrations of ^{170}Er, ^{170}Yb, ^{171}Yb, and ^{172}Yb in highly irradiated ^{169}Tm were determined by stable isotope dilution and mass spectrometry. The relative abundances of ^{169}Tm, ^{170}Tm, and ^{171}Tm were also found. From this information, it was calculated that the electron capture to electron emission ratio for ^{170}Tm is 1.44 ± 0.03 × 10^{-3} and the reactor neutron cross section of ^{169}Tm in a well-moderated neutron flux is 133 ± 7 barns. The amounts of the various isotopes determined are consistent with reactor neutron cross sections for ^{170}Tm and ^{171}Tm of 128 ± 10b and ~1b, respectively. (auth) (UK)

1897 MASS SPECTROMETRIC STUDY ON DOUBLE β DECAY. Takaoka, N.; Okano, J.; Ogata, K. (Osaka Univ.). pp 943-53 of Advances in Mass Spectrometry. Vol. 4. Kendrick, E. (ed.). London, Elsevier Publishing Co., 1968.

From 4th International Conference on Mass Spectroscopy, Berlin. See CONF-670920.

In order to extend double β-decay investigations, isotopic analyses of xenon from tellurium ore and of krypton from selenium ore were carried out with a high-sensitivity mass spectrometer. For the xenon experiment, in order to find out the temperature at which the excesses would be predominant, the gas extraction was performed by 100°C stepwise heating in the 200 to 1000°C temperature range. The excess xenon at 130, 129, 131, and 128 were found as previously, and these excesses appeared sharply and at the same temperature step for each sample. The excess release temperatures depend on mineral type. The roughly estimated amounts of ^{130}Xe excesses from the three samples employed support the conclusion that the greatest part of the excesses are due to ^{130}Te 2β decay. The other excesses at masses of 129, 131, and 128 seem to be more complicated. For different samples, even if they are obtained from the same mine, the excess ratios of these isotopes have different values. These excesses may be rather complex mixtures of various nuclear process products, and the decisive mechanisms for such excesses may have to await further critical experimental investigations for many different kinds of samples. For krypton analyses, a slight excess of about 1 per cent was found at mass 82. This excess may be mainly due to the ^{82}Se 2β decay. The half-life of the decay was roughly estimated to be 7×10^{19} to 9×10^{20} years. Further measurements are being carried out. (auth) (UK)

1898 PROPERTIES OF THE K = ½ GROUND STATE ROTATIONAL BANDS IN ^{169}Tm and ^{171}Tm. Kaufmann, E. N.; Bowman, J. D.; Bhattacherjee, S. K. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Phys., A119: 417-34(1968).

Nuclear magnetic moments of the $I^\pi = 5/2^+$ and $7/2^+$ states of the K = ½ rotational bands in ^{169}Tm and ^{171}Tm were measured using the perturbed $\gamma\gamma$ angular correlation method. Gamma-ray intensity ratios were examined in the decay of ^{171}Er, and the mixing amplitude δ(E2/M1) of the 109.8 keV transition in ^{169}Tm has been determined. These and other data are used to determine rotational model parameters as well as transverse and longitudinal effective spin g-factors. Qualitative agreement is found with the theory developed by Bochnacki and Ogaza, however results are not in quantitative agreement with the theoretical predictions. The possible origin of the discrepancies is discussed. (auth)

1899 NUCLEAR MAGNETIC DIPOLE MOMENT OF ^{165}Ho. Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer., 58: 1519-23(Nov. 1968).

The first energy interval of the $4f^{11}6s$ configuration of Ho II was recently found by Spector and Sugar to be 637.8 cm^{-1}. The hfs of four of the lines defining this interval were measured with an HYPEAC spectrometer at a resolution of 600,000. Seven independent equations relating the splitting factors a_{6s}, a_{4f}, and b_{4f} to the measured hfs were derived. Known values of a_{4f} and b_{4f} from Ho I (deduced in an atomic-beam magnetic-resonance experiment) were inserted in these equations, giving a_{6s} = 0.4437 cm^{-1} (corrected for core polarization) with a probable error of 0.0004 cm^{-1} From a_{6s}, a value for the nuclear magnetic dipole moment μ_I = 3.94 ± 0.05 μ_N was derived. The uncertainty of μ_I is the rms deviation due to uncertainties of a_{6s}, and $|\psi_{6s}^2(0)$, the value of the probability density of the 6s electron at the nucleus. (auth)

1900 PROMPT NEUTRONS FROM FISSION OF ^{233}U BY 8.5- AND 13.0-MeV PROTONS. Burnett, S. C.; Ferguson, R. L.; Plasil, F.; Schmitt, H. W. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 21: 1350-3(Oct. 28, 1968).

A comparison of the number of neutrons emitted as a function of fragment mass is reported for 8.5- and 13.0-MeV proton-induced fission of ^{233}U. The results indicate that the excitation energies of the light fragments do not change appreciably, while those of the heavy fragments increase with increasing incident energy. The increase in fragment excitation for masses of ~132 amu (Z ≅ 50, N ≅ 82) is significantly greater than that in compound-nucleus excitation and is accompanied by a decrease in fragment kinetic energy. (auth)

1901 STUDY OF THE ^{138}Ba(d,p)^{139}Ba REACTION FOR INCIDENT ENERGIES BELOW THE COULOMB BARRIER. Rapaport, J.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A119: 641-57 (1968).

The ^{138}Ba(d,p)^{139}Ba reaction was studied with incident deuteron energies between 5.0 and 7.5 MeV in steps of 0.5 MeV. Proton groups observed at 7.5 MeV corresponding to states in ^{139}Ba up to 4.0-MeV excitation are reported. The differential cross sections of proton groups corresponding to the ground state, first and second excited states were measured. The stripping analysis for those transitions is discussed using a DWBA formalism, and values for the reduced normalization and spectroscopic factors versus deuteron energy are given. (auth)

1902 CONFIGURATION MIXING IN ^{169}Yb. Michaelis, W.; Weller, F.; Schmidt, H.; Markus, G.; Fanger, U. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Phys., A119: 609-40(1968). (In German).

The level structure of ^{169}Yb was studied by radiative capture of thermal neutrons in ^{168}Yb. High resolution measurements of the gamma-ray spectrum were performed using a Ge(Li) anti-Compton spectrometer in the low-energy region and a Ge(Li) pair spectrometer for the high-energy transitions. The target was Yb_2O_3 enriched to 19.5% in ^{168}Yb thus corresponding to a cross section contribution of $(97.5\frac{\sigma_g}{\sigma_2})$% for ^{168}Yb. More than 300 gamma lines were detected in the spectrum. The high accuracy of the data allows the application of Ritz' combination principle to excitation energies up to 1.5 MeV. The results clearly demonstrate the presence of remarkable band-mixing effects. The neutron binding energy was found to be 6867.21 ± 0.46 keV. Theoretical calculations were performed which take into account pair correlation, quasiparticle-phonon interaction, rotation-vibration interaction and Coriolis coupling. The energy and structure of individual levels, the ratios of intensities for gamma-ray transitions, and multipolarity admixtures are predicted. In general, good agreement is achieved between the theoretical calculations and the experimental results. (auth)

1903 RELATIVE BLOCKING EFFECTS IN K = 2 AND BETA VIBRATION BANDS. Davidson, M. G. (Western Washington State Coll., Bellingham). Nucl. Phys., A119: 568-76(1968).

A study of blocking effects in rotation and vibration bands in deformed even nuclei is made using a perturbed symmetric model. In particular the extent of blocking effects in K = 2 bands (gamma vibration bands of the symmetric model) is compared with the extent of blocking effects in β-vibration bands for various nuclei. The difficulty of applying the symmetric model to those nuclei where the effects may be most directly compared is discussed. Results from nuclei examined suggests that the K = 2 bands in deformed even nuclei are more rotational than vibrational in character. (auth)

1904 ACTIVATION CROSS SECTIONS OF Sn ISOTOPES FOR 14-MeV NEUTRONS. Lulic, S.; Strohal, P.; Antolkovic, B.; Paic, G. (Inst. Rudjer Boskovic, Zagreb). Nucl. Phys., A119: 517-24(1968).

The cross sections for (n,2n) and (n,p) reactions were measured for several tin isotopes by the activation method and compared with compound-nucleus theory. Fairly good agreement between the measured (n,2n) cross sections and the predictions of the statistical model was obtained, while disagreement between experiment and theory for the (n,p) reaction is interpreted as caused by the presence of direct processes. The cross sections for (n,p) reactions show a decreasing trend with increasing neutron number. The ratio σ_m/σ_g was measured for transitions to several isomeric states in (n,p) reactions. (auth)

1905 PERTURBED ANGULAR CORRELATION MEASUREMENTS OF ^{187}Re. DeGrazia, Allan Richard. Pullman, Wash., Washington State Univ., 1968. 94p.

Thesis.

Differential angular correlation measurements of the 480- and 72-keV gamma-ray cascade in ^{187}Re were made as a function of the physical state of the radioactive source, ^{187}W. Various liquid and solid sources were used. The anisotropies measured using a metallic tungsten rod (A = −0.183 ± 0.036) and an isotropic polycrystalline metallic powder (A = −0.182 ± 0.031), both having a cubic body-centered structure, were nearly twice as large as that observed using a saturated ammonium tungstate solution (A = −0.108 ± 0.017). Experimentally measured anisotropy values for both metallic tungsten sources agreed with the theoretical value (A = −0.184). These results strongly suggest that the angular correlation function measured using an ammonium tungstate solution is highly perturbed. Experimental results obtained indicate that the measured angular correlation function of an ammonium tungstate solution is not dependent on the concentration of the solution or its pH. It was also shown that increasing the viscosity of an ammonium tungstate solution by a factor of 80 does not impart a large time-dependent perturbation. However, a small time-dependent perturbation did occur, indicating that the measured angular correlation function of a pure ammonium tungstate solution had not reached a hard core value of a static interaction. These experimental results and the differential angular correlation measurements of an ammonium tungstate solution over a time interval of 0.0−1.1 μs suggest that this perturbation must occur within the first 80 ns after the emission of the 480-keV gamma-ray. It is postulated that this perturbation is due to some mechanism related to the preceding beta decay process. One likely mechanism could be bond-breaking, which may result from recoiling of the ^{187}Re nucleus following the emission of a 630-keV beta particle from the parent nucleus, ^{187}W. The calculated recoil

energy is 3.0 eV, which is considered sufficient to break a single metal-oxygen bond, but not large enough to displace a rhenium atom in a crystal lattice. The resultant distortion of the assumed tetrahedral perrhenate ion (ReO_4^-) structure existing in solution could cause strong field gradients at the site of the decaying nucleus, alter the population of the magnetic sub-levels of the intermediate state, and consequently produce a strong time-dependent perturbation with a relaxation time less than 80 ns. The differential angular correlation measurements are consistent with the spin values, $^9/_2$ and $^5/_2$, for the energy levels at 206 and 686 keV, respectively, and the assignment of pure E2 and E1 transitions to the 480- and 72-keV gamma rays, respectively. These results agree with the conclusions based upon conversion ratio measurements, but disagree with the findings of other workers who have made angular correlation measurements on tungstate ions in solution. The above postulate would explain this latter discrepancy. (Disser. Abstr.)

1906 COLLECTIVE NUCLEAR STRUCTURE STUDIES IN THE OSMIUM NUCLEI. Casten, Richard Francis Xavier. New Haven, Yale Univ., 1968. 230p.

Thesis.

Collective nuclear structure studies on the four even-even isotopes ^{186}Os, ^{188}Os, ^{190}Os, and ^{192}Os were performed using Coulomb excitation induced by ^{16}O ions with incident energies between 42 and 80 MeV. The Os isotopes span the important transition region from highly deformed to nearly spherical nuclei located at the high mass extremity of the rare earth region of collectivity and have therefore long been the center of much theoretical and experimental interest. The deexcitation radiation was observed singly, in coincidence with ^{16}O ions backscattered from the target, and in coincidence with other γ rays representing the $2^+ \rightarrow 0^+$ and $4^+ \rightarrow 2^+$ transitions in each isotope. In ^{186}Os, ^{188}Os, and ^{190}Os all levels through the 6^+ state of the ground state rotational band as well as the 2^{+1} and 4^{+1} levels of the so-called γ-vibrational band were excited. In ^{188}Os an additional 0^+ level at 1086 keV was observed while in ^{192}Os all known states except the unnatural parity 3^+ level were detected. Furthermore, in ^{188}Os, ^{190}Os, and ^{192}Os new states at 780, 840, and 855 keV, respectively, are tentatively proposed with J^π assignments of 2^+ or 3^- ascribed as likely and not inconsistent with measurements. The main emphasis was on the extraction of absolute reduced transition probabilities (B(E2) values). These were obtained, for the excitation of all states previously known, by both model-dependent and model-independent analyses. The results were compared with several macroscopic and microscopic nuclear models, with particular attention to that of Kumar and Baranger. The latter has proved the most complete and successful of any in predicting both absolute B(E2) values and the variations of these with neutron number in the Os isotopes. The trend toward the spherical or vibrational limit in ^{192}Os was calculated to be somewhat sharper than is observed experimentally. Suggestions are made for possible improvements in the pairing-plus-quadrupole model of these authors. An interpretation of the Os isotopes as typified by shallow potential minima for moderately prolate deformations (and slightly axially asymmetric equilibrium configurations in ^{190}Os, ^{192}Os) and by extreme softness to vibrations in both β and γ emerges from this comparison and is actually confirmed by both the successes and failures of the other models with which comparisons are made. Discussion is also made of the possible existence and implications of infinite excited state quadrupole moments predicted in Os by Kumar and Baranger and in other spherical nuclei by other authors. Finally, suggestions for future experimental tests of the theoretical calculations in this transition region are offered. (Disser. Abstr.)

1907 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF RADIOACTIVE TRANSITION-METAL IONS. Easley, Warren Cliett. Berkeley, Calif., Univ. of California, 1967. 161p.

Thesis.

Electron paramagnetic resonance (EPR) was observed in 253d ^{110m}Ag, present as Ag^{2+} in the $[(iso\text{-}C_3H_7)_2NCS_2]_2Ag$ complex. Eleven hfs (hyperfine structure) lines were observed, the positions of the other two lines being obscured by other absorptions present in the sample, and the nuclear spin of 6 was confirmed. A hfs constant $a_{110m} = 7.108 \pm 0.02 \times 10^{-3}$ cm^{-1} was determined. A hyperfine anomaly of $\Delta_{107,109} = -0.40\% \pm 0.1\%$ was observed for stable Ag^{2+} in this complex, indicating that the hfs arises from contact interaction. A nuclear moment of $\mu_{110m} = +3.55 \pm 0.04$ nm was derived after a 3.7% hyperfine-anomaly correction. The nuclear moment does not agree with shell-model predictions using empirical g factors, being low by 1 nm. It is suggested that the $(g_{7/2})^7$ proton configuration might be coupled to spin $^1/_2$. This yields a moment of +3.54 nm. EPR experiments on yttrium ethylsulfate single crystals containing terbium isotopes in the ratios ^{158}Tb/^{157}Tb/^{159}Tb = 25/1.6/1 were carried out at Q-band frequencies (35 GHz). The nuclear spin of ^{158}Tb was found to be 3 and by comparison with the observed hyperfine structure of ^{159}Tb and its known nuclear moment, a magnetic moment $\mu^{158} = 1.740 \pm 0.007$ nm was calculated. Transitions due to ^{157}Tb were not observed, presumably because they were obscured by the stronger ^{159}Tb lines. Assuming $^{159}I = {}^{157}I = {}^3/_2$, the following limits were set on the value of μ^{157}: $1.88 \leq \mu^{157} \leq 2.10$. ^{160}Tb lines were also observed in YES single crystals. They gave $\mu^{160} = 1.685 \pm 0.008$ nm. Nuclear alignment experiments on ^{158}Tb in a single crystal of neodymium ethylsulfate were also carried out in order to determine a relation between the quadrupole coupling constant and the magnetic hyperfine structure constant. This information, as well as existing nuclear orientation results on ^{160}Tb, was combined with the EPR data to obtain quadrupole coupling constants. Quadrupole moments calculated from the coupling constants were found to be $Q^{158} = 2.7 \pm 0.5$ barns and $Q^{160} = 3.0 \pm 0.5$ barns. The first well-verified divalent actinide ion, $Am^{2+}(5f^7$, nominal $^8S_{7/2})$, was stabilized in a calcium fluoride single crystal and characterized by EPR and optical spectroscopy. Reduction of the trivalent ion was obtained by solid-state electrolysis and/or as a result of the emission of ionizing α radiation during the americium nuclear decay. The radiation-reduced crystals were observed to thermoluminesce at 500°C; emitting radiation characteristic of the Am^{3+} ion. The electrolytically reduced crystals did not thermoluminesce. EPR measurements at liquid helium temperatures showed the Γ_8 crystal-field state to be lowest in energy. The X-band EPR spectra were fitted with the following spin Hamiltonian parameters: $|g| = 4.490 \pm 0.002$, $|A|$ (^{243}Am) $= 1.821 \pm 0.002 \times 10^{-2}$ cm^{-1}, $|A|$(^{241}Am) $= 1.837 \pm 0.002 \times 10^{-2}$ cm^{-1}, $^{241}I = {}^{243}I = {}^5/_2$. Analysis of the americium hfs allowed the determination of a contact hfs constant (corrected for the effect of the crystal field) $a_c = (-)\,9.01 \times 10^{-3}$ cm^{-1}. This is equivalent to a hyperfine magnetic field per unpaired 5f electron of (-) 285 kilogauss. Measurements on isoelectronic $^{244}Cm^{3+}$(I = 0) at sites of cubic symmetry were also carried out, yielding an isotropic g value which agreed within experimental error with that of Am^{2+}. Two charge-compensated sites with trigonal symmetry about the [1$\bar{1}$1] axes of the cube were also observed. The components of the g tensors were found to be $g_{||}$(site I) $= 3.41 \pm 0.02$, $g_\perp$(site I) $= 6.88 \pm 0.02$, $g_{||}$(site II) $= 2.69 \pm 0.02$, $g_\perp$(site II) $= 5.91 \pm 0.02$. Subsequent studies at Q-band frequencies allowed the cubic crystal-field splittings to be determined. The splitting between the ground Γ_8 state and the first excited Γ_8 state was found to be 13.4 ± 0.5 cm^{-1} and 18.6 ± 0.5 cm^{-1} for cm^{3+} and Am^{2+} at cubic sites in CaF_2, respectively. The splittings are shown to be due primarily to the effects of intermediate coupling on the ground state wavefunction. (Disser. Abstr.)

1908 NOTE ON THE DETERMINATION OF BRANCHING RATIOS BY THE SUM-COINCIDENCE METHOD. De Pinho, A. G.; Do Amaral, L. C. M. (Univ. Catolica, Rio de Janeiro). An. Acad. Brasil. Cienc., 40: 111-17(June 30, 1968).

The conditions under which a sum-coincidence spectrometer can safely be used to obtain information about branching ratios were investigated, and experimental verification of the mathematical approximations was obtained. Branching ratios for the second 2^+ states in ^{198}Hg and ^{122}Te were measured. (D.C.W.)

1909 DETERMINATION OF SOME EXCITATION FUNCTIONS FOR DEUTERON REACTIONS WITH ^{141}Pr. Lange, J.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 9: 66-71(Aug. 1968). (In German).

The excitation functions of the (d,p), (d,2n), and (d,3n) reactions with ^{141}Pr were determined for particle energies up to 50 MeV. A special monitoring method was used for the flux determination. Ratios of the cross sections (d,2n) : (d,p) were measured in cases where the deuteron energy was too low for the ^{27}Al(d,αp)^{24}Na monitoring reaction. Thick target yields were calculated. The numerical analysis of the decay curves yielded the following half-lives: ^{140}Nd, 3.37 ± 0.02 day; ^{141}Nd, 2.60 ± 0.12 hr; ^{142}Pr, 19.09 ± 0.07 hr. (auth)

1910 MEASUREMENT OF THE STATIC ELECTRIC QUADRUPOLE MOMENT OF THE 0.558 MeV 2+ STATE IN ^{114}Cd BY MEANS OF THE REORIENTATION EFFECT IN COULOMB EXCITATION. Schilling, Gerd. Cleveland, Case Western Reserve Univ., 1967. 142p.

Thesis.

The static electric quadrupole moment of the 0.558-MeV 2^+ state in the ^{114}Cd nucleus was measured by observing the differential excitation probability of 25-MeV incident ^{16}O ions. Deviations of the excitation probability from first-order Coulomb excitation theory are interpreted in terms of the "reorientation effect" of Breit to yield $Q(2+) = -0.64 \pm 0.19 \times 10^{-24}$ cm^2, which is in strong disagreement with the vanishingly small prediction of the pure vibrational model. The experimental technique of using a large scintillator close to the target to gate several ion detectors in order to separate inelastic ions allows the measurement to be performed at low incident beam energy, where higher-order corrections involving virtual transitions to higher excited states

contribute a small uncertainty to the reorientation effect. (Disser. Abstr.)

1911 NUMERICAL CONSTRUCTION OF LEVEL SCHEMES: ^{149}Pm. Helmer, R. G. (Idaho Nuclear Corp., Idaho Falls); Backlin, A. Nucl. Instrum. Methods, 65: 31-44(Oct. 15, 1968).

A method of constructing a more complete level scheme from the energies of the associated gamma-ray transitions and a few known levels is illustrated. The number of possible new levels obtained in an energy region is compared with the number of levels expected from a set of random transition energies. In certain cases, this allows one to conclude, with a known probability of being right, that the possible level does exist. The method is illustrated by construction of the level scheme of ^{149}Pm from the 155 transitions observed in the decay of ^{149}Nd. (auth)

1912 THE ^{127}I(n,p)^{127m}Te, ^{127}I(n,p)^{127}Te, AND ^{127}I(n,2n)^{126}I MEAN FISSION NEUTRON CROSS SECTIONS. De Regge, P.; Dams, R.; Hoste, J. (Ghent Univ.). Radiochim. Acta, 9: 57-61 (Aug. 1968).

The mean fission neutron cross sections of the ^{127}I(n,p)^{127m}Te, ^{127}I(n,p)^{127}Te, and ^{127}I(n,2n)^{126}I reactions were determined experimentally from the absolute ^{127m}Te, ^{127}Te, and ^{128}I activities induced in irradiated potassium iodide. For this purpose a quantitative method for separation of tellurium from iodine was developed using liquid-liquid extraction of iodine and precipitation of tellurium by means of hydrazine hydrate. The absolute tellurium activity was measured with a calibrated Geiger-Mueller tube, whereas the iodine activity was measured by gamma spectrometry. For the cross sections of the reactions ^{127}I(n,p)^{127m}Te and ^{127}I(n,p)^{127}Te respective values of 11.1 ± 0.2 μ barn and 7.62 ± 0.11 μ barn were obtained. For the cross section of the reaction ^{127}I(n,2n)^{126}I, a value of 0.64 ± 0.010 mbarn was found. (auth)

1913 FISSION OF IRIDIUM AT INTERMEDIATE EXCITATION ENERGY. Brodzinski, Ronald Lee. Lafayette, Ind., Purdue Univ., 1968. 135p.

Thesis.

The fission resulting from the helium ion bombardment of naturally occurring ^{191,193}Ir was studied radiochemically and by a plastic fission track technique. Thin targets were prepared by vacuum evaporation of iridium metal onto silver and aluminum foils, and absolute cross sections were determined for the production of eleven nuclides from fission induced by 42.2-MeV helium ion bombardment. The excitation function was determined by measuring the total fission cross section at thirteen different energies. Individual fission products were purified, and their activities were measured using low background beta counters. Decay curves and theoretical treatment of the Γ_f/Γ_n data were resolved by computer programmed least squares analyses. The mass distribution was observed to be symmetric with a full width at half maximum of 23 ± 2 mass units. The average number of neutrons emitted per fission event was 2 ± 1 neutrons. The total fission cross section was found to be 45 ± 11 microbarns. The value of the fission level density parameter was found to be approximately given by A/10, and the ratio of a_f/a_n was found to be 1.18. The fission threshold was determined to be 22.3 ± 0.7 MeV. (Disser. Abstr.)

1914 ISOMERIC CROSS-SECTION RATIOS FOR (n,2n) REACTIONS INDUCED BY 14.7-MeV NEUTRONS IN In AND Sb. Minetti, B.; Pasquarelli, A. (Politecnico, Turin). Z. Phys., 217: 83-90(1968).

Isomeric cross-section ratios were measured for (n,2n) reactions induced by 14.7 MeV-neutrons in In and Sb isotopes. Experimental results were compared with the theoretical calculations performed with the Huizenga and Wandenbosch method. (auth)

1915 DECAY OF ^{115}Sb. Rahmouni, O. (Institut d'Etudes Nucleaires, Algiers). Nuovo Cim., 57B: 389-98(Oct. 11, 1968). (In French).

The decay of ^{115}Sb was studied with Ge(Li) spectrometers and Na(I) photomultipliers. Both γ single and coincidence measurements were made. The half-life for ^{115}Sb was determined to be 31.8 ± 2 min. Twelve new γ transitions were observed in addition to the previously known transitions. Two possible level schemes are suggested for ^{115}Sn. (auth)

1916 SPECTRUM OF NEUTRONS PRODUCED BY 6.1-MeV NEUTRONS IN ^{238}U. Chuang, L. S. (Chinese Univ. of Hong Kong). Chin. J. Phys. (Peking) (Engl. Transl.), 6: 25-8(Apr. 1968).

An experimental determination of the parameter T which characterizes the temperature of the evaporated residual nucleus of ^{239}U after being bombarded with neutrons of 6.1-MeV energy was made. From the analysis of the composite neutron spectrum recorded in the Ilford C-2 emulsions of 100 microns thickness, the value for T was found to be 0.70 ± 0.05 MeV. (auth)

1917 MEASUREMENTS OF THE CONVERSION LINES OF THE 742 keV TRANSITION IN THE DECAY OF ^{143}Pm. Berenyi, D.; Varga, L. (Inst. of Nuclear Research, Debrecen, Hungary). Acta Phys. Acad. Sci. Hung., 24: 431-2(1968).

Conversion lines in the decay of ^{143}Pm were recorded using a toroid-sector-type β spectrometer with a resolution of about 3%. The α_K conversion coefficient for the 742-keV transition in ^{143}Nd was determined, as was the ratio $\alpha_K/\alpha_L + \alpha_M$ for this transition. The results indicate that the most probable multipolarity of the transition is E2, which indicates a spin-parity assignment of $\frac{3}{2}^-$ for the 742-keV state of ^{143}Nd. (D.C.W.)

1918 THE LEVEL SCHEMES OF ^{134}Ba AND ^{171}Tm. Raeside, David Edward. Ann Arbor, Mich., Univ. of Michigan, 1968. 109p.

Thesis.

The gamma spectra associated with the beta decay of ^{134}Cs and the beta decay ^{171}Er were studied with curved-crystal and Ge(Li) spectrometers. The data provide energy and intensity measurements of 11 gamma rays in the ^{134}Cs decay and 39 gamma rays in the ^{171}Er decay. Coincidence measurements were also made. Level schemes for ^{134}Ba and ^{171}Tm are proposed. There is no evidence for the previously proposed levels at 1570 and 1773 keV in ^{134}Ba. Two very weak gamma rays at 243 and 327 keV were measured with the curved-crystal spectrometer and were assigned to the decay of ^{134}Cs. These two transitions can be placed between well-established levels in the ^{134}Ba level scheme. No evidence was found for the levels at 489 and 591 keV which other investigators have placed in the ^{171}Tm level scheme. New levels at 862 and 1285 keV are proposed for the ^{171}Tm level scheme. Three new gamma rays which can be placed between well-established levels in ^{171}Tm were measured. The existence of several transitions above 1000 keV in the decay of ^{171}Er was confirmed. (Diss. Abstr.)

1919 SHELL-MODEL CALCULATION OF THE EVEN-MASS TIN ISOTOPES INCLUDING CORE EXCITATION. Clement, David M.; Baranger, Elizabeth Urey (Univ. of Pittsburgh). Nucl. Phys., A120: 25-58(1968).

The Tabakin interaction is used as the residual interaction in a shell-model calculation of the even-mass tin isotopes in which twelve single-particle proton and neutron levels are included and in which the BCS quasi-particle approximation is made. The Hamiltonian is diagonalized in a space consisting of neutron two-quasi-particle states and proton particle-hole states. The calculation is done including second-order corrections in the matrix elements; the results are insensitive to these. The calculated excitation energies of the first 2^+ and 3^- states agree with experiment to within a few hundred keV for all isotopes. Inclusion of the proton states is important. The lowest 1^- level occurs below the ground state and has a large overlap with the spurious center-of-mass state; levels with other spins occur at reasonable values. (auth)

1920 FISSION CROSS SECTIONS ^{243}Pu, ^{250}Bk, ^{247}Cm, ^{245}Cm, ^{254m}Es, and ^{254}Es, AND ODD–ODD SYSTEMATICS. Diamond, H.; Hines, J. J.; Sjoblom, R. K.; Barnes, R. F.; Metta, D. N.; Lerner, J. L.; Fields, P. R. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 30: 2553-9(Oct. 1968).

Fission cross sections as measured in back-to-back ion chambers in a graphite thermal column of a reactor are: ^{243}Pu, 196 ± 16 barns; ^{250}Bk, 960 ± 150 barns; ^{247}Cm, 108 ± 5 barns; ^{245}Cm, 2040 ± 80 barns; ^{245m}Es, 1840 ± 80 barns; ^{254}Es, 3060 ± 180 barns. A more accurate beta decay half-life of 4.955 ± 0.003 hours was found for ^{243}Pu. Of the 12 known thermal neutron fission cross sections for odd-neutron and odd-proton target nuclei, only one cross section is more than a factor of 2.3 from 1350 barns. A more striking uniformity is observed in the ratio of thermal neutron fission cross section to target spin: eight of the ten known ratios are grouped at 600 ± 320 barns per spin unit. The dependency of fission cross section upon target spin is also shown by the three sets of isomers (^{254}Es, ^{242}Am, ^{244}Am) in which the higher fission cross section for each pair is associated with the higher spin isomer. No simple correlation between the fission cross section and the calculated compound nucleus level-density was found. (auth)(UK)

1921 ISOBARIC ANALOG RESONANCES IN STRIPPING AND PICKUP REACTIONS. Stein, Nelson; Coffin, J. P.; Whitten, C. A. Jr.; Bromley, D. A. (Yale Univ., New Haven). Phys. Rev. Lett., 21: 1456-9(Nov. 11, 1968).

Resonance structure was observed in many (d,p) and (p,d) excitation functions in the lead region. The results are compared with previously reported (t,p), (p,t), and (d,p) data, and systematic resonance behavior is found common to all stripping and pickup reactions involving incident or final protons. Resonances occurred whenever the proton-channel energies were between 16 and 18 MeV. This is the energy region where single-particle isobaric analog states occur in the reaction ^{208}Pb(p,p). (auth)

1922 PRODUCTION CROSS SECTIONS OF SOME I, Te, Ba, AND Cs ISOTOPES FROM THE INTERACTION OF 1, 2, AND 2.9-GeV PROTONS WITH URANIUM. Chu, Y. Y.; Hahn, R. L. (Brookhaven National Lab., Upton, N. Y.). J. Inorg. Nucl. Chem., 30: 2561-9(Oct. 1968). (BNL-11992).

Cumulative and independent cross sections were determined radiochemically for the production of the isobaric chains 127, 129, 132, 134, and 139 from the reactions of 1-, 2-, and 2.9-GeV protons with uranium. Comparisons were made with the results of other workers. The reported data of the neutron-deficient nuclides are consistent with the neutron-deficient wings of the charge dispersion curves (cross section vs neutron to proton ratio) at these energies, and the production cross sections for neutron-excess nuclei lie considerably higher than the charge-dispersion curves indicate. The half-life of ^{127}Ba was also determined to be 13.0 ± 0.5 min. (auth)(UK)

1923 HALF-LIVES AND ACTIVATION CROSS SECTIONS OF SOME RADIOISOTOPES OF I, Te, AND Sb FORMED IN THE INTERACTIONS OF IODINE WITH 14.7-MeV NEUTRONS. Qaim, S. M.; Ejaz, M. (Atomic Energy Centre, Lahore). J. Inorg. Nucl. Chem., 30: 2577-81(Oct. 1968).

Accurate half-lives and absolute activation cross sections were estimated as follows: ^{128}I: 25.5 ± 0.3 min and $\sigma_{n,\gamma}$ = 7.2 ± 1.2 mb; ^{128}I: 13.02 ± 0.07 day and $\sigma_{n,2n}$ = 1128 ± 120 mb; ^{125}I: 58 ± 2 day and $\sigma_{n,xn}$ = 40 ± 15 mb; ^{127}Te: 9.23 ± 0.13 hr and $\sigma_{n,p}$ = 8.9 ± 1.0 mb; and ^{124m}Sb: 21.3 ± 0.8 min and $\sigma_{n,\alpha}$ = 1.5 ± 0.2 mb. At this particle energy direct interaction processes also contribute. A search for the alleged 2.6-hr isomeric state in ^{126}I showed that this activity probably does not exist. (auth)(UK)

1924 MASS SPECTROMETRIC MEASUREMENT OF THE HALF-LIFE OF ^{241}Pu. Cabell, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem., 30: 2583-9(Oct. 1968).

Changes in the isotopic composition of a mixture of ^{240}Pu, ^{241}Pu, and ^{242}Pu were measured over a period of four and a half years by means of mass spectrometry. From the rate of decay of ^{241}Pu relative to the other two isotopes, its half-life was found to be 14.98 ± 0.33 yr. (auth)(UK)

1925 NEW DETERMINATION OF THE HALF-LIFE OF ^{243}Am. Brown, L. C.; Propst, R. C. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. J. Inorg. Nucl. Chem., 30: 2591-4(Oct. 1968). (DP-MS-67-123).

The half-life of ^{243}Am was determined by two independent analytical methods (coulometry and mass spectrometry) in combination with alpha pulse-height analysis and absolute alpha counting. The two results are in good agreement at 7370 ± 40 years. (auth)(UK)

1926 ENERGY LEVELS OF ^{96}Mo EXCITED IN THE DECAY OF THE ^{96m,g}Tc ISOMERIC PAIR AND ^{96}Nb. Monaro, S.; Barrette, J.; Boutard, A. (Univ. of Montreal). Can. J. Phys., 46: 2375-98(Nov. 1, 1968).

The γ-ray spectra accompanying the decay of ^{96g}Tc(4.3 d) and ^{96m}Tc(52 m), produced in the reactions ^{96}Mo(p,n)^{96}Tc and ^{97}Mo(p,2n)^{96}Tc, were studied with lithium-drifted Ge detectors. Gamma rays (relative intensities are in parentheses) of 314.2 ± 0.2 (2.4), 316.3 ± 0.2 (1.5), 434.8 ± 0.4 (0.8), 460.2 ± 0.4 (0.48), 568.9 ± 0.4 (.95), 778.2 ± 0.2 (100), 812.5 ± 0.2 (83), 849.8 ± 0.2 (98), 1091.3 ± 0.4 (0.9); 1126.8 ± 0.3 (15.3), 1200.0 ± 0.4 (0.41), and 1497.7 ± 0.5 keV (0.081), plus several other very weak lines, have been observed in the decay of ^{96}Tc (4.3 d). Several transitions never previously reported were found in the decay of ^{96m}Tc (52 m). All but four of these transitions could fit already known excited levels in ^{96}Mo at 778.2, 1497.9, 1628.0, 1869.6, and 1978.3 keV, whereas the placing of the remaining 616.1-, 966.6-, 1096.6-, and 1816.2-keV gamma rays required the existence of a new level in ^{96}Mo at 2594.5 keV. In view of the results obtained from the study of the decay of the ^{96}Tc isomeric pair, it was considered very desirable to reinvestigate the decay of ^{96}Nb to levels in ^{96}Mo. The ^{96}Nb source was produced in the reaction ^{96}Zr(p,n)^{96}Nb. Ge(Li) detectors were again employed and gamma-gamma directional correlation measurements were performed with two NaI(Tl) crystals, a fast coincidence circuit, and a multiparameter analyzer to record the data. The experimental directional correlation coefficients of the 1200.1-778.2, 1200.1-460.1, 778.2-460.1, 1091.4-778.2, 1091.4-568.7, and 778.2-568.7 keV cascades are given. These values seem to be compatible with spin assignments of 4^+, 3^+, and 5^+ for the 1869.6-, 1978.3-, and 2438.4-keV levels in ^{96}Mo, respectively. (auth)(CANADA)

Nuclear Theory

Refer also to abstracts 1580, 1787, 1789, 1800, 1806, 1807, 1812, 1825, 1831, 1833, 1842, 1843, 1845, 1851, 1859, 1876, 1894, 1897, 1903, 1908, and 1919.

1927 (AD-671630) ON THE N-NUCLEON ENERGY EIGENSYSTEM. Loder, Rurik K. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). June 1968. 26p. (NDL-TR-109). CFSTI.

The expectation value for energy eigenvalue states of a closed N-nucleon system is written as a proper sum and integration over the product of all internal parameters of which the quantity $\psi^*\psi$ is a function. With the aid of the Fourier-transformed delta-function for the center-of-mass conservation, it is possible to reduce the successive 3N integrations to only one integration over the three-dimensional vector of a product of (N-1) + 1 integral functions and to carry out these integrations. (auth) (USGRDR)

1928 (AD-671692) THEORETICAL NUCLEAR PHYSICS. Final Report, January 5, 1962-June 30, 1968. Breit, Gregory (Yale Univ., New Haven, Conn.). June 30, 1968. Contract DA-31-124-ARO(D)-183. 24p. (AROD-893:120-P). CFSTI.

A discussion of the unitary-model-operator approach to the correlation problem in nuclei is presented, and some calculational details are discussed. Results are reported for Hartree-Fock calculations carried out with an effective interaction derived from the Yale potential. The spherical nuclei ^{16}O and ^{40}Ca are considered. The orbitals are expanded in terms of harmonic-oscillator functions, and the dependence of the results on the number of oscillator functions used and upon the oscillator size parameter is studied. Work during this period was carried on along the following lines: nucleon-nucleon scattering; effective interactions between nucleons in finite nuclei; nucleon-nucleon elastic scattering; phase-shift analysis of elastic pion-nucleon scattering; photodisintegration of the deuteron; heavy ion scattering and transfer reactions, and Coulomb excitation. (USGRDR)

1929 (COO-1265-67) ANNUAL REPORT ON NUCLEAR PHYSICS, 1968. (Minnesota Univ., Minneapolis. John H. Williams Lab. of Nuclear Physics). Aug. 1968. Contract AT-(11-1)-1265. 224p. Dep. CFSTI.

Several investigations of charged-particle reactions and scattering are summarized; information on the energy levels, Coulomb displacement energies, and radii of many nuclei is presented. Theoretical research on the optical model for nucleon scattering is outlined. Development of a windowless target chamber and of polarized proton and negative ion sources for the Van de Graaff accelerators is reported, together with the development of charged-particle identification systems, photoplate scanners, pulse divider circuits, a pair spectrometer, helium polarimeters, and target fabrication techniques. (D.C.W.)

1930 (IPNO/TH-126) TRANSCRIPTION OF THE QUASI-PARTICLE IN IDEAL SPACE AND THE BOSON METHOD. Simard, P. A. (Paris Univ., Orsay (France). Institut de Physique Nucleaire). May 1968. 28p. Dep.

A transcription of the quasiparticle into the ideal space is written in such a way that all the terms which contribute for the three-quasiparticle system in QTD approximation can be found. Canonical transformations between the ideal quasiparticles are studied. An application to one shell is done with the result that the boson method gives exactly the same spectra as the Kuo method. (auth)

1931 (JINR-P4-4069) MAGNETIC DIPOLE INTERACTIONS IN DEFORMED NUCLEI PROPERTIES OF THE K = ½ STATES. Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1968. 18p. (In Russian). Dep.

The spin polarization effects in odd-mass deformed nuclei are considered as being caused by the "scattering" of the odd nucleon on the core 1^+ excitations. This leads to the renormalization of the single-particle matrix elements $\langle\sigma_z\rangle$ and $\langle\sigma_+\rangle$. The corresponding contributions to the magnetic moment are accounted for by using the effective factors g_s^* and g_l^*, which are calculated by theory. It is shown that the renormalization of the matrix element $\langle\sigma_+\rangle$ results in the change of the sign of the decoupling parameter for the Nilsson state $\frac{1}{2}^-[510]$. (auth)

1932 (KFKI/25/1968) MEASUREMENT OF THE INTERNAL MAGNETIC FIELD BY PERTURBED ANGULAR CORRELATION METHODS. Keszthelyi, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). 1968. 16p. Dep.

The method of perturbed γ angular correlations and distributions is outlined, and the application of the perturbed correlation technique to the investigation of nuclear moments and internal magnetic fields is discussed. (D.C.W.)

1933 (TID-24733) EFFECTIVE NUCLEON-NUCLEON INTERACTIONS AND THE MICROSCOPIC DESCRIPTION OF NUCLEON-NUCLEUS SCATTERING. Love, William Gary (Tennessee Univ., Knoxville). Dec. 1968. 134p. Dep. CFSTI. Thesis.

A microscopic description is given of the inelastic scattering of nucleons from nuclei. Of particular interest in this work are those low-lying levels in nuclei near closed shells. More specifically, an effective nucleon-nucleon interaction, t_{eff}, is sought which, when used in the distorted-wave approximation, yields the correct transition amplitudes between two nuclear states of the above type. Since at very high energies the impulse approximation should be valid, it is used as a guide at the energies with which this work is concerned (e.g., $E \lesssim 150$ MeV). For all energies in this range the impulse approximation is found to be too weak when a simple shell model description of the nuclear states is used. For example, near 20 MeV it is found to predict less than 10 percent of the observed cross section. To investigate t_{eff} and consequently its departure from the impulse approximation, attention is focused on two principal aspects of the problem: the inclusion of core polarization effects, and the inclusion of exchange or knock-out terms in the transition amplitudes. The inclusion of the effects due to core polarization involves a renormalization of the effective interaction between the projectile and the valence nucleons of the target induced by closed shell or "core" participation in intermediate excited states. This renormalization has been carried out in perturbation theory where a macroscopic model of the core is used. The core coupling parameters are obtained by applying this model to the relevant electromagnetic transitions for which the interaction is known. This model has been applied to the scattering of nucleons with bombarding energies from 10 to 150 MeV from several nuclei near closed shells with the result that core polarization effects are found to be extremely important. In fact, in this energy range these effects are found to dominate the impulse approximation. However, the impulse approximation plus the core coupling term is still too weak below about 60 MeV. Presently the inclusion of exchange effects of the knock-out type are being considered also. Although there are no results of numerical calculations to report as yet, the formalism is developed and a qualitative study of these knock-out terms is presented. The necessary computer program is currently being developed. This phase of the study should allow one to critically evaluate terms that have been until recently almost universally ignored. These knock-out terms introduce amplitudes that are forbidden by the direct theory alone and should be interesting to study as mechanisms for "direct forbidden" transitions. (74 references) (auth)

1934 (UCRL-18355) NUCLEAR STRUCTURE, FISSION, AND SUPERHEAVY ELEMENTS. Lecture Notes. Nilsson, Sven Goesta (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1968. Contract W-7405-eng-48. 126p. Dep. CFSTI.

The problem of nuclear stability is discussed in terms of the semiempirical mass formula. Spontaneous fission of superheavy elements is examined from the points of view of both statics and dynamics. (J.W.R.)

1935 (UCRL-18445) LECTURES ON EFFECTIVE INTERACTIONS, EFFECTIVE OPERATORS AND CLOSED SHELL NUCLEI. Zamick, Larry (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1, 1968. Contract W-7405-eng-48. 37p. Dep. CFSTI.

Nucleon interactions outside of a closed shell are discussed. This type of interaction is described by an effective interaction using operators developed from the effective charge concept. The importance of core polarization and the limitations and justification of the effective interaction and effective operators are discussed. (J.W.R.)

1936 RESULTS OF CALCULATIONS ON A DYNAMIC MODEL OF ASYMMETRIC FISSION. Hasse, R. W. (Univ., Wuerzburg, Ger.). Phys. Lett., 27B: 605-7(Oct. 14, 1968).

The motion of the compound nucleus $^{235}U + n_{th}$ from the saddle point up to the scission points is computed for various random initial coordinates. The resulting mass distribution, kinetic-energy distribution and variances of the fission-fragment kinetic-energy distribution are presented. (auth)

1937 EFFECTIVE NUCLEAR FORCE OF A REALISTIC POTENTIAL: A SELF-CONSISTENT APPROACH. Gmitro, M. (International Atomic Energy Agency, Trieste, Italy). Phys. Lett., 27B: 616-18(Oct. 14, 1968).

Core polarization corrections to the Tabakin realistic nucleon-nucleon potential have been calculated by a selfconsistent method. The derived residual interaction is demonstrated by the example of the tin isotope spectroscopy. (auth)

1938 CONSTRUCTION OF STATISTICAL NEUTRON RESONANCES. Dyos, M. W. (Westinghouse Electric Corp., Madison, Pa.). Nucl. Sci. Eng., 34: 181-8(Nov. 1968).

The statistical method for calculating neutron cross sections in the unresolved resonance region was extended to permit the construction of ladders for higher angular momentum neutrons and for all accessible spin states (and substates) of the compound nucleus. The new method is an improvement over existing methods in that a fitting procedure is adopted to ensure that the constructed sequence of resonances reproduces resonance integrals inferred from low-resolution experimental results. The s- and p-wave components of the capture cross section of ^{238}U were computed between 4 and 80 keV using a sequence of resonances obtained by fitting over the energy range 4 to 15 keV. The calculated ^{238}U capture cross section is in excellent agreement with published data in the energy range 25 to 60 keV. (auth)

1939 A REMARK ON THE GENERATOR-COORDINATE METHOD AND THE QUASI-BOSON APPROXIMATION. Ui, H.; Biedenharn, L. C. (Duke Univ., Durham, N. C.). Phys. Lett., 27B: 608-10(Oct. 14, 1968).

By use of Bargmann's integral transform and the coherent state formalism, it is proved that the generator-coordinate method with quadratic approximation to the kernels (= Gaussian kernels) is completely equivalent to the quasi-boson approximation to the original Hamiltonian. (auth)

1940 INFLUENCE OF A SELF-ENERGY TERM IN NUCLEAR PAIRING CALCULATIONS. Silverberg, Lars (Univ. of Lund, Sweden). Nucl. Phys., A119: 385-97(1968).

The influence of a term $\Sigma_\nu F_\nu V_\nu^4$ in a conventional BCS pairing calculation is investigated. For large values of F_ν a variation calculation shows new types of minimas which roughly correspond to an excitation of a pair out of the Fermi sea. This could explain some irregularities in the nuclear systematics and especially the strange $1/2$ ground-state spin of the silver and rhodium isotopes can (at least qualitatively) be understood in this picture. (auth)

1941 SINGULAR LIPPMANN-SCHWINGER EQUATIONS AND THE UNIFIED THEORY OF NUCLEAR REACTIONS. Poepel, Bertram (Univ., Heidelberg). Nucl. Phys., A119: 325-336(1968).

State normalization for a special type of singular Lippmann-Schwinger equation is investigated. The unified reaction theory of MacDonald is based on equations of this type. It is shown that the resolvent method can not be used to obtain the formal solutions of these equations. It is further shown that the expressions given by MacDonald are valid only in the simple case for which the targets and residual nuclei have a pure shell-model configuration or for elastic scattering. (auth)

1942 SOME STUDIES OF REALISTIC FORM FACTORS FOR NUCLEON-TRANSFER REACTIONS. Philpott, R. J. (Vanderbilt Univ., Nashville); Pinkston, W. T.; Satchler, G. R. Nucl. Phys., A119: 241-89(1968).

The effect of nuclear structure details on pick-up and stripping form factors is investigated. After a short review of other calculations, an approximate method is set up in which the form factor emerges as the solution of an inhomogeneous differential equation. The requirement that the derived spectroscopic amplitudes agree with corresponding shell-model amplitudes is shown to impose a condition on the potentials employed. For pick-up reactions involving the "small" components of the wave functions, structure effects often tend to enhance the form factor in the surface region. For stripping reactions, the opposite is true. The $^{58}Ni(p,d)$ reaction has been studied in some detail with particular attention to the effect produced by different choices for the nuclear wave functions and residual nucleon-nucleon force. The distorted-wave analysis, which mediates the comparison with experiment, is critically appraised. Although the derived angular distributions do not vary greatly, the extracted spectroscopic factors are found to be sensitive to the assumptions used. In addition, some preliminary work on the $^{40}Ca(p,d)$ reaction is reported. (auth)

1943 POSITRON STRAGGLING THROUGH THIN FOILS. Nishi, Masatsugu; Mazaki, Hiromasa (Kyoto Univ.). Nucl. Phys., A119: 467-75(1968).

An experimental study of positron straggling in thin absorbers was performed with the aid of a Siegbahn-Slätis intermediate-image spectrometer mounted with a ^{22}Na source. The energy of the incident positron was chosen as 300 keV. Targets used were aluminium, nickel, tin, tantalum and lead with thicknesses up to about 40 mg/cm^2. The most probable energy losses of positrons in traversing the absorbers show good agreement with the Rohrlich-Carlson theory when the absorbers are thin enough, but for rather thick absorbers the experimental results fail to fit the theory. It has also been found that the straggling distributions agree well with the theoretical values calculated from the Blunck-Leisegang theory. (auth)

1944 SENIORITY-ZERO EXCITED STATES AND THE INTERMEDIATE STATE METHOD. Chasman, R. R. (Argonne National Lab., Ill.). Nucl. Phys., A119: 476-80(1968).

The intermediate-state method is applied to the problem of seniority-zero excited states of the pairing Hamiltonian. A set of linear equations, whose coefficients are ground-state expectation values, is obtained. The method is applied successfully to the pairing-vibration problem. (auth)

1945 COLLECTIVE EXCITATIONS OF EVEN–EVEN ATOMIC NUCLEI. Davydov, A. S. (Inst. of Theoretical Physics, Kiev). At. Energy Rev., 6: No. 2, 3-58(1968).

A review dealing with theoretical research on collective excited states of even–even nuclei is presented. The classification of excited states in spherical and non-sperical nuclei is investigated. Attention is focused on the phenomenological theory of quadrupole excited states, the different approximations in this theory being investigated. It is shown that in phenomenological theory the energies of excited states and the probabilities of electromagnetic transitions between them can be expressed by a certain number of parameters which characterize the shape of the nucleus in its ground state and its deformability. The theory of octupole excited states is briefly set out. The connection is noted between the phenomenological theory and the "microtheory" of collective excited states. (98 references) (auth)

1946 PARITY-MIXED CONFIGURATIONS USING A SIMPLE MODEL. Mueller-Schwartz, J. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A119: 337-46(1968).

Parity-mixed configurations with $j = 3/2$ are examined using a four-particle model, whose complete solution can be calculated exactly with arbitrary interaction. Only the residual interaction is varied, and this is simulated as a sum of the one-pion-exchange-force (OPEP) and an attractive δ force. As the OPEP is made stronger, a 0^- state comes down to the ground state. Then the ground state can be described in terms of a Hartree–Fock (HF) ansatz with parity mixing. On the other hand, as the attractive central force is strengthened, the 0^- state goes up in energy, and the spectrum becomes very similar to the experimental spectrum of ^{18}O. This fact indicates the possible importance of the configurations for certain excited states of nuclei. In the δ-force case, the ground state can not be well approximated by any quite general HF state. But within the framework of a normal pairing (BCS) ansatz, it is well reproduced. (auth)

1947 EXTENSIONS OF GRIFFIN'S STATISTICAL MODEL FOR MEDIUM-ENERGY NUCLEAR REACTIONS. Blann, Marshall (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 21: 1357-60 (Oct. 28, 1968).

The new statistical model due to Griffin has been extended to include charged-particle emission by evaluation of the transition matrix in terms of a relative velocity and scattering cross section. Additionally a quite different formulation is derived for the equilibrium emission probability, where as the precompound emission probability is similar to Griffin's result. (auth)

1948 EFFECTIVE INTERACTIONS IN THE DEUTERON–NUCLEUS SYSTEM. Austern, N.; Richards, K. C. (Univ. of Pittsburgh). Ann. Phys. (N. Y.), 49: 309-19(Sept. 1968).

Effective interactions for use in three-body models of the deuteron–nucleus system are derived by orderly elimination of excitations of internal coordinates of the target nucleus. The interactions are expressed in terms of the individual nucleon–nucleus optical potentials. (auth)

1949 STRONG ABSORPTION MODEL FOR SCATTERING OF NEUTRONS. Rahman, M. (Atomic Energy Centre, Dacca, Pakistan); Banerjee, A.; Sen Gupta, H. M. Ann. Phys. (N. Y.), 49: 320-38(Sept. 1968).

The strong absorption model of Frahn and Venter was used in analyzing the angular distributions of about 14-MeV neutrons elastically scattered from a number of nuclei between Be and Pb over a wide range of scattering angles. From the best-fit parameters of the model, the interaction radius and surface diffuseness were obtained. The parameter values were also used to analyze the inelastic scattering data leading to the quadrupole excitation of some even–even nuclei and the deformation parameter β_2 was extracted in each case and was compared with that from the DWBA analysis. (auth)

1950 DETERMINATION OF SPECTROSCOPIC FACTORS FROM ELASTIC PROTON SCATTERING THROUGH THE ISOBARIC ANALOGUE RESONANCES. Harney, H. L. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A119: 591-608(1968).

Lane's model provides the basis for the calculation of spectroscopic factors of parent analogue states from the corresponding isobaric analogue resonances in elastic proton scattering. The assumptions of the method as well as dependences of the results on various parameters are discussed. The formulas obtained from Lane's model are compared to the results of other theories. It is shown that this model is best suited for numerical calculations. A comparison with the formulas of Weidenmüller's microscopic theory is made, and improvements of the underlying approximations are proposed. (auth)

1951 ELLIOTT ANGULAR MOMENTUM STATES PROJECTED FROM THE GEL'FAND U(3) BASIS. Draayer, J. P.; Pursey, D. L.; Williams, S. A. (Iowa State Univ., Ames). Nucl. Phys., A119: 577-90(1968).

Eigenstates of the total orbital angular momentum and one component thereof are obtained by projection from the extremal U(3) basis states for the isotropic harmonic oscillator. A rule complementary to that given by Elliott for the requisite quantum number K is given and the interpretation of the use of K in state labeling is clarified. An explicit form for the normalization and overlap integrals of the projected states is developed in a form convenient for machine coding. (auth)

1952 VALIDITY OF THE RPA APPROXIMATION IN A SOLVABLE TWO-MODE MONOPOLE MODEL. Agassi, Dan (CEN de Saclay, Gif-sur-Yvette, France). Nucl. Phys., A119: 497-516(1968).

The validity of the RPA and second-order perturbation theory approach for the energies is examined by comparison with the exact solution of a two-vibrational-modes model. It is found, for the investigated region of the parameters, that the use of phenomenological single-particle energies in the RPA matrix is crucial for making the approximation good. Results of the perturbation-theory approach are found comparable to the RPA ones. (auth)

1953 CONCERNING AN ANSATZ FOR THEORETICAL IMPROVEMENT OF OPTICAL POTENTIALS FOR DEUTERON SCATTERING BY HEAVY NUCLEI. Elk, K.; Feige, B. (Univ., Dresden). Nucl. Phys., A119: 658-66(1968). (In German).

The elastic scattering of deuterons on nuclei is studied. The characteristic transition probabilities for this process are reduced to the two-particle Green function. By an appropriate partial summation of the perturbation series, this Green function can be written in the form of a two-particle Green function in an external field. This external field is identical with the optical potential of the nucleons, and for the interaction between the nucleons of the deuteron, an effective two-particle interaction results. The identity of all nucleons involved is always taken completely into account. Assuming certain approximations regarding the change of the inner deuteron structure during the scattering process, an equation for the optical deuteron potential is obtained which is an improvement of the available equations. Contrary to nucleon scattering, an exact basis for the deuteron optical model, however, does not exist. The numerical calculation of the improved optical potentials is in satisfactory agreement with the experimental results. (auth)

1954 HIGHLY EXCITED STATES OF ATOMIC NUCLEI. Amus'ya, M. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.), 8: 52-4(July 1968).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 8: 86-9(July 20, 1968).

The quasiparticle approach to the shell model is used to explain qualitatively highly excited states. It is shown that the quasiparticle potential far away from the Fermi surface is greater than the potential well depth calculated neglecting nonlocality in the self-consistent field. (J.W.R.)

1955 HIGH-ENERGY CURRENTS AND NUCLEI. Faucher, G. (Laboratoire de Physique Generale, Paris). Nuovo Cim., 57A: 830-6(Oct. 21, 1968).

The Cabibbo-Horwitz-Ne'eman model of factorized residues is applied to proton and antiproton interactions with nuclei. Theoretical calculations are compared with experimental data in nuclear emulsions. (auth)

1956 NUCLEAR REACTION ANALYSIS. GRAPHS AND TABLES. Marion, J. B.; Young, F. C. New York, John Wiley and Sons, Inc., 1968. 174p. $12.00.

Graphs and tables that are useful to the experimental nuclear physicist in reaction analysis are presented. These include information on charged-particle interactions with matter, gamma-ray detection, radiology and shielding, nuclear parameters, calibration energies, reaction kinematics, and other assorted topics in reaction analysis. (J.W.R.)

1957 SURFACE DISTRIBUTIONS OF ALPHA PARTICLES FROM EVEN–EVEN NUCLEI. Sharma, R. C. (Sir George Williams Univ., Montreal). Nuovo Cim., 57B: 437-52(Oct. 11, 1968).

The alpha-particle distributions on the nuclear surface are calculated for a number of even-even α-emitting nuclei, by an approximate method based on Nosov's work and resembling Fröman's. The calculations are extended to higher-order expansion terms of the alpha-particle wave function. A qualitative compari-

son is made with the results obtained by method of inward integration using experimental branching ratios. Conclusions are drawn about the effects of the l = 6 partial wave on the alpha-particle distributions. (auth)

1958 ABSOLUTE ELECTRON FLUXES AND ENERGIES IN THE INNER RADIATION ZONE IN 1965. Chapman, Mac C.; Farley, Thomas A. (Univ. of California, Los Angeles). J. Geophys. Res., 73: 6825-34(Nov. 1, 1968).

Electron intensities and spectrums for $1.18 < L < 1.75$, measured in late 1965 with a directional electron spectrometer on the OV1-2 (1965-78A) spacecraft are reported. Unidirectional intensities normal to the field line ($j_\perp$) and computed omnidirectional fluxes are given for electrons of energies greater than 0.56 MeV. Maximum omnidirectional intensity above this energy in November 1965 was 4.6×10^7 electrons cm^{-1} sec^{-1} at L of 1.35. Electron spectrums for the energy range from 1 to 5 MeV near the geomagnetic equator are displayed. The spectrums fall more rapidly than an exponential in this energy range. Comparisons with data from other experiments show decay constants of the order of one year, with shorter lifetimes and softer spectrums indicated at low altitudes. The slow and continuous disappearance of these electrons, injected by the Starfish nuclear explosion in July 1962, is consistent with diffusion loss processes. (auth)

1959 CHANGES IN THE SINGLE-PARTICLE MOTION DUE TO COLLECTIVE STATES. Weigel, M. (Univ., Munich). Nuovo Cim., 57B: 527-30(Oct. 11, 1968).

It is shown that the change in single-particle potential due to resonances in the response function can be obtained without the use of perturbation theory. (J.W.R.)

1960 FURTHER STUDIES OF THE HARTREE–FOCK APPROXIMATION IN FINITE NUCLEI. Tarbutton, R. M. (Carnegie-Mellon Univ., Pittsburgh); Davies, K. T. R. Contract Nonr-760(15)NR-024-439. Nucl. Phys., A120: 1-24(1968). (ORNL-P-3700).

New developments in spherical Hartree–Fock techniques make possible very fast calculations of heavy nuclei like ^{208}Pb and the superheavy elements. With these methods, studies can be made using harmonic oscillator wave functions with a large number of radial nodes and including the physically important relative l-values. Some sample Hartree–Fock results are presented for a velocity-dependent effective interaction recently developed. Single-particle energies and wave functions, rms charge and mass radii, total binding energies, densities, and overlaps of single-particle wave functions with pure harmonic oscillator wave functions were calculated for the nuclei ^{16}O, ^{40}Ca, ^{48}Ca, ^{56}Ni, ^{88}Sr, ^{90}Zr, and ^{208}Pb. Studies of the ^{208}Pb densities and overlaps strongly suggest that it is necessary to use a dimensionality somewhat greater than pure oscillator functions in calculating heavy nuclei. The origin of spin-orbit splitting in light and heavy nuclei is also discussed. In heavy nuclei, it is shown that the incomplete filling of a $j = l \pm \frac{1}{2}$ doublet has an important effect on the splittings of the single-particle levels. (auth)

1961 ELASTIC SCATTERING OF HEAVY IONS. Simbel, M. H. (Cairo Univ.); Abul-Magd, A. Y. Nucl. Phys., A120: 152-60(1968).

Elastic scattering of strongly absorbed projectiles is considered for the case when the Coulomb interaction parameter is large. The surface diffuseness of the absorption region and the effect of real nuclear phase shifts are taken into account explicitly. A convenient mathematical form of the dependence of the scattering coefficient on the orbital angular momentum is assumed. An approximate analtyic expression for the cross section is obtained and used to discuss the influence of the nuclear surface on the elastic scattering of heavy ions. The theory is successfully applied to the analysis of the experimental data on scattering of ^{12}C ions by different atomic nuclei. (auth)

1962 IMPROVED INVERSE GAP EQUATION PROCEDURE FOR QUASIPARTICLE CALCULATIONS. Gambhir, Y. K. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Phys., A120: 193-219(1968).

An improvement in the inverse gap equation (IGE) method is proposed in which the fed single-quasiparticle energies are corrected either by the second-order perturbation theory or by the modified Tamm–Dancoff approximation (MTDA) theory at each iteration. The procedure is fast converging. The behavior of the extracted quantities for odd Ni isotopes is reasonably close to their expected theoretical behavior. The extracted Hartree–Fock (HF) energies are highly sensitive to the choice of the effective two-body interaction. These quantities are used in calculating the various quasiparticle quantities for the corresponding even Ni isotopes through the BCS or pairing-model equations. Quasiparticle configuration-mixing calculations are performed for both odd and even Ni isotopes using their respective sets of quasiparticle quantities obtained by the conventional BCS, IGE, and the improved IGE procedures. These sets of quasiparticle results are compared and their relative merits discussed. (auth)

1963 GENERATOR COORDINATE THEORY OF COLLECTIVE MOTION. Brink, D. M.; Weiguny, A. (Oxford Univ.). Nucl. Phys., A120: 59-93(1968).

Collective motion in many-particle systems is studied by using the generator-coordinate method of Griffin, Hill, and Wheeler. The equations of the theory are solved in the Gaussian overlap approximation and are shown to be equivalent to the quantal equations of a set of coupled harmonic oscillators. General properties of the solutions are studied, including those resulting from invariance principles and intrinsic symmetries with the Tamm–Dancoff approximation and the random phase approximation are pointed out. Normally the generator-coordinate method is formulated in terms of generating functions depending on real parameters. Various difficulties of the "real" approach can be overcome by making an extension to complex parameters. Relations between the real and complex representation are established. To illustrate the general formalism, the method is applied to the alpha-particle model of ^{20}Ne. (auth)

1964 NUCLEAR STABILITY IN THE REGION OF 158 NEUTRONS. Viola, V. E. Jr. (Univ. of Maryland, College Park). J. Inorg. Nucl. Chem., 30: 2601-16(Oct. 1968).

The nuclear decay properties of the very heavy elements were examined in order to investigate the apparent instability for nuclides with 158 or more neutrons. The recent data for the energetics and lifetimes of alpha-, beta-, and spontaneous fission decay were found to be generally consistent with earlier predictions for species with neutron number N = 140 to 157, but for $N \geq 158$ it appears that spontaneous fission instability is much greater than expected from semiempirical calculations based on a unified nuclear model. This result is interpreted as a possible indication of anomalous behavior in the nuclear level structure of the heaviest nuclei. The Garvey–Kelson mass relation was also studied for use in extending the heavy element mass surface. It was found that this relation gave results generally consistent with Way–Wood systematics, but was inferior to the latter type of extrapolation because of inconsistencies with the more sensitive systematics of alpha decay. (auth)(UK)

REACTOR TECHNOLOGY

Commercial Power Reactors

1965 (ACNP-68505-D) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME IV. INSTRUMENTATION, CONTROL, AND ELECTRICAL DISTRIBUTION. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). June 1968. Contract AT(11-1)-850. 367p. Dep. CFSTI.

Instrumentation, control, and electrical distribution systems necessary for plant operation are described. Each section discusses a specific system and is divided into function, system description, components descriptions, and operating procedures subsections. The operating procedures subsection contains the procedures required to ensure that the equipment is operating properly prior to plant startup and includes procedures for periodic testing to be performed on various systems during plant operation. (H.D.R.)

1966 (ACNP-68505-E) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME V. SERVICE SYSTEM. (Allis-Chalmers Mfb. Co., Bethesda, Md. Atomic Energy Div.). May 1968. Contract AT(11-1)-850. 307p. Dep. CFSTI.

The service systems which furnish the plant with air, water, steam, etc., are described. Each section discusses a specific system and is divided into subsections covering function, system description, components descriptions, and operating procedures. The operating procedures contain the test procedures required to ensure that the equipment is operating properly prior to plant startup and during plant operating and shutdown periods. (H.D.R.)

1967 (ACNP-68505-F) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME VI. REFUELING. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 1968. Contract AT(11-1)-850. 132p. Dep. CFSTI.

The components and procedures used in the fuel and control rod handling system for loading, transfer, and storage of new and irradiated fuel elements, control rods, and fuel shroud cans are described. The system also provides the facilities for removal and installation of the reactor vessel head and the internal components whose removal is required during fuel and control rod handling operations. Operating procedures are detailed for the removal, storage, and reinstallation of each component. (H.D.R.)

1968 (ACNP-68505-G) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME VII. WASTE COLLECTION AND TREATMENT. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Apr. 1968. Contract AT(11-1)-850. 95p. Dep. CFSTI.

Liquid waste generated within the reactor and turbine buildings is collected and stored in large retention tanks. The wastes are periodically sampled, analyzed, and either transfered to the waste treatment building or discharged to the river. High level wastes are treated in the waste treatment building either by ion exchange or concentration by evaporation. Concentrated wastes are solidified in drums and shipped off-site for disposal. The waste collection, transfer, and treatment equipment and procedures are described in detail. (H.D.R.)

1969 (ACNP-68505-H) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME VIII. WATER CHEMISTRY. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). July 1968. Contract AT(11-1)-850. 186p. Dep. CFSTI.

The apparatus and procedures for determining constituents in reactor steam and water are described. General principles of safe laboratory practices, preparation and standardization of carrier solutions, and counting techniques and data handling are presented. Radiochemical procedures for determining the activity of selected radioisotopes are discussed, and dissolution methods for the removal of sorbed activity from ion exchange resins and for the dissolution of insoluble corrosion products which flake off metal surfaces and are transported through the cooling system are presented. The schedule and means for sampling the various reactor and generator plant auxiliary systems are described. (H.D.R.)

1970 (ACNP-68505-K) LA CROSSE BOILING WATER REACTOR OPERATING MANUAL. VOLUME XI. INDUSTRIAL SAFETY. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Aug. 1968. Contract AT(11-1)-850. 78p. Dep. CFSTI.

The program that has been established for maintaining a safe work environment for all employees and for ensuring that all operations are performed in a manner that will minimize the possibility of personal injury or damage to equipment, materials, and property is presented. Safety and fire protection equipment and procedures and the education and training programs covering all pertinent phases of safety are described. (H.D.R.)

1971 (AECL-2712) DOUGLAS POINT HWR STARTUP PHYSICS MEASUREMENTS AND PREDICTIONS. Pasanen, A. A.; Blansche, J. F. (Atomic Energy of Canada Ltd., Sheridan Park (Ontario)). Oct. 1967. 76p. (CONF-680601-32). Dep. CFSTI. CAN $2.00.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The measurements made during Phase B (zero power) commissioning of the Douglas Point heavy water power reactor, which provide useful reactor physics data, are described in detail. The calculations that were done prior to startup are described, and the measured results are compared with predictions. Possible reasons for discrepancies between predictions and measurement are discussed. (auth)

1972 (APDA-225) SUMMARY OF MECHANICAL EQUIPMENT EXPERIENCE IN THE ENRICO FERMI ATOMIC POWER PLANT. Duffy, J.; Ford, J.; Matte III, J. (Atomic Power Development Associates, Inc., Detroit, Mich.). May 1968. Contract AT(11-1)-865. 68p. Dep. CFSTI.

The highlights of the experiences encountered with the major reactor mechanisms, fuel handling system equipment, and heat transport system components of the Enrico Fermi Atomic Power Plant that are significant to the future development of large LMFBR central station units are described. Discussion of fuel, nuclear, and other nonmechanical aspects of the Fermi plant design and operation are intentionally excluded. A summary description of the plant design and arrangement, a brief history of operations, and an assessment of operating experience, including the design and performance of the individual major mechanisms and components of the plant are presented. The notable design requirements and objectives, design alternatives, and other important considerations that were involved in the development of the mechanical features of the plant are briefly described. The discussion of each mechanism or component includes an evaluation of special problem areas. Considerations that would be involved in application or adaptation of the equipment to a large LMFBR central station unit are also discussed. (30 references). (auth)

1973 (CEA-R-3297) FLUX MAPPING BY SEMI-CONDUCTOR DETECTORS IN EDF 3 REACTOR. Tarabella, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1968. 46p. (In French). Dep.

Semiconductor neutron detectors were used for extensive flux mapping in the graphite-gas EDF-3 reactor. The maps were used to evaluate the hypotheses developed to account for flux tilting in large reactors. (TSS) (auth)

1974 (DOCKET-50305-1) KEWAUNEE NUCLEAR POWER PLANT. Facility Description and Safety Analysis Report, Amendment 4, Suppl. 2. (Wisconsin Public Service Corp., Green Bay). Apr. 1, 1968. 165p. Dep. CFSTI.

Shutdown capability and control and fuel rod analyses are given for the Kewaunee Power Reactor. Details of containment system construction are discussed. Structural design bases for Class I structures are listed; leak tightness criteria for valve selection for the Shield and Auxiliary Building Vent Systems are discussed. Leakage rate testing of steam line isolation valves is considered; criteria for testing are given. Seismic analyses of containment structures are discussed; Shield Building integrity is evaluated. Performance of the Emergency Core Cooling Systems is detailed; capability for detecting and isolating recirculation system leaks is evaluated. (M.L.S.)

1975 (DOCKET-50305-2) [KEWAUNEE NUCLEAR POWER PLANT]. [Facility Description and Safety Analysis Report], Amendment 1. (Wisconsin Public Service Corp., Green Bay). Jan. 2, 1968. 440p. Dep. CFSTI.

Additional or revised information on the Kewaunee Power Reactor is given for the following major categories: soils and foundation design criteria; seismic design criteria; containment design basis; containment penetration and isolation systems; containment and engineered safeguards systems quality assurance and testing; nuclear steam supply system safeguards analysis, design, control, and quality assurance; emergency power; startup procedures; emergency plans; waste releases; service water intake system; and response to the 70 General Design Criteria. (M.L.S.)

1976 (DOCKET-50305-3) KEWAUNEE NUCLEAR POWER PLANT. Facility Description and Safety Analysis Report, Volume

1, Sects. 1–6. (Wisconsin Public Service Corp., Green Bay). Aug. 23, 1967. 650p. Dep. CFSTI.

Information on Kewaunee Power Reactor is given under the following main headings: Introduction and Summary; Site; Reactor; Reactor Coolant System; Containment System; and Engineered Safeguards including emergency core cooling, containment vessel internal spray, and containment vessel air handling system. (M.L.S.)

1977 (DOCKET-50305–4) KEWAUNEE NUCLEAR POWER PLANT. Facility Description and Safety Analysis Report, Volume 2, Sects. 7–14, Apps. (Wisconsin Public Service Corp., Green Bay). Aug. 23, 1967. 688p. Dep. CFSTI.

Information on Kewaunee Power Reactor is given under the following major topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion Systems; Radioactive Wastes and Radiation Protection; Conduct of Operations; Initial Tests and Operation; and Safety Analyses including core and coolant boundary protection, standby safeguards analysis, and rupture of a reactor coolant pipe. (M.L.S.)

1978 (DOCKET-50305–5) KEWAUNEE NUCLEAR POWER PLANT. Facility Description and Safety Analysis Report, Volume 3, Apps. (Wisconsin Public Service Corp., Green Bay). Sept. 23, 1967. 440p. Dep. CFSTI.

Information on Kewaunee Power Reactor is included under: special design procedures, overall plant requirements, power escalation test program, containment capability, foundation design criteria, and construction quality assurance program. (M.L.S.)

1979 (IDO–17273) THE CAROLINAS VIRGINIA TUBE REACTOR PRELIMINARY LEAKAGE RATE TEST RESULTS. Bingham, G. E. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Oct. 1968. Contract AT(10-1)-205. 83p. Dep. CFSTI.

The results of a preliminary leakage rate test conducted on the Carolinas Virginia Tube Reactor (CVTR) containment system are presented. The primary purpose of the test was to investigate the accuracy and sensitivity of the CVTR continuous leakage rate measurement system. Additionally, the testing effort provided valuable experience and insight that will be useful in planning and performing future in-plant tests at CVTR. Tabular and graphic results of the test are presented which compare the leakage rate measured by both the reference vessel and absolute methods. Also included are brief descriptions of the facility, the test procedure, and the test instrumentation. The test results indicate that a continuous leakage rate system would be a valuable asset to any power reactors' engineered safety systems since it provides a continuous, rapid, and sensitive indication of the integrity of the containment system. (auth)

1980 (NP–17648) POWER AND RESEARCH REACTORS IN MEMBER STATES. (International Atomic Energy Agency, Vienna (Austria)). Jan. 1968. 55p. Dep.

The 20th periodic summary table of nuclear power reactors in operation, under construction, or planned in the member states of the IAEA is presented. Also included is a list of research reactors in operation or under construction. To illustrate the growth of installed capacities of power reactors and the number of research reactors, numerical tables and graphs are presented. A map giving the location of nuclear power plants in the IAEA member states is also presented. (D.C.C.)

1981 (TID–24752) QUARTERLY REPORT NO. 23 [ON SENA REACTOR PROJECT], JANUARY 1–MARCH 31, 1968. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). Apr. 29, 1968. 37p. (In English and French). Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

Operations at the SENA Power Reactor during January to March 1968 are described. Fuel assemblies inventory is presented for April 1967 and February 1968. Reactor expenditures as of December 1967 are presented. (D.C.C.)

1982 THE 340-MW NUCLEAR POWER STATION ATUCHA WITH A SIEMENS NATURAL URANIUM PWR. Frewer, H.; Keller, W. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 13: 350-8(July 1968). (In German).

A description of the proposed Argentine nuclear power plant Atucha is given. The predicted installed power around Buenos Aires is tabulated as a function of year. A layout of the reactor is shown; design parameters are tabulated. Heat transfer and auxiliary systems are described. (M.L.S.)

1983 PROBLEMS IN THE INSTRUMENTATION AND CONTROL OF LARGE NUCLEAR POWER STATIONS. Merz, L. (Technische Hochschule, Munich). Atomwirtschaft, 13: 491-5 (Oct. 1968). (In German).

The problems of instrumentation, control and plant protection in the case of nuclear power stations gain added significance through two trends in their construction: the increase in capacity and the increasing nearness of sites to densely populated areas. In-core instrumentation has particular significance, especially for the measurement of neutron flux. Basically the simplest and most logical control concept, even for nuclear power stations, is offered by the division into two separate but close-meshed control circuits: turbine control and reactor control. Surprisingly this concept was not adopted in many nuclear power stations. On the contrary a single, very wide control circuit is set up which covers both reactor and turbines. The careful separation of the control system from the protection system is of special significance. It is important to recognize that incorrect information in respect of important operating data can be very dangerous when it occurs simultaneously in both systems. At the same time a distinction must be made in each case between dangerous and harmless defects. It is also difficult to decide how frequently the safety system should be tested when it functions with relays or, as a new development, with semi-conductor elements. An early diagnosis of reactor damage would be of great value for reactor safety and is possible by analysis of so-called neutron noise and, in the case of pressurized water reactors, also of acoustic noise. Process computers are used today in nuclear power stations particularly for the calculation of the spatial power density in the reactor core. (auth)

1984 EXPERIENCES WITH THE SAFETY AND SHUT DOWN SYSTEMS OF GERMAN REACTORS. Bastl, W. (Technische Hochschule, Munich). Atomwirtschaft, 13: 509-11(Oct. 1968). (In German).

Experience with the testing of safety and shut-down systems as well as rod drives has shown that test arrangements built in from the outset are of great value for the safe operation of installations. The flexible organization of test cycles according to experience with definite components and according to operating time has proved a success. In the design of test facilities it is particularly important to take care that they can — in case of necessity — cope with increased test frequencies. Testing and experience is reported in terms of the nuclear power stations VAK, KRB, MZFR as well as of the research reactor FR-2. (auth)

1985 THE STADE NUCLEAR POWER STATION: LAYOUT INSTALLATION ENGINEERING. Gawande, H. (Nordwestdeutsche Kraftwerke Aktiengesellschaft, Hamburg). At. Strom., 14: 93-101(July-Aug. 1968). (In German).

The layout of the Stade 660 MW nuclear power station is described. The primary installation for the pressure-water reactor, the secondary installations, the measuring, supervision and control arrangements as well as the regulation behavior of the reactor are described. Finally, a review is given on construction engineering and on the electrical installations. (auth)

1986 BROWNS FERRY NUCLEAR PLANT MOVES AHEAD. Strauss, Sheldon D. Power, 112: 82-3(Nov. 1968).

A description of the construction progress on the Browns Ferry Power Reactor is presented. (D.C.C.)

1987 THE PROBLEMS OF FUEL LOADING INTO THE EDF 2 REACTOR AT THE CHINON POWER PLANT. Landais, J. P.; Falquet, R. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 70, 39-46(May-June 1968). (In French).

A brief description of the fuel elements for the EDF-2 reactor is given; fuel element loading is discussed. The fuel loading machine is described in detail. Difficulties involved in putting the fuel handling machine into service are detailed. (M.L.S.)

1988 DESIGN OF THE INTEGRATED PRIMARY CIRCUIT AT EDF 4. Gaussot, D.; Brignon, P. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 71: 18-23(May-June 1968). (In French).

The advantages and problems of integrated primary circuits are listed. Construction of the primary circuit for EDF-4 is reviewed; a vertical cross section of the reactor is shown. Effects of coolant loss accidents are summarized. (M.L.S.)

1989 COMPONENT DESIGN FOR THE EDF-4 PRIMARY CIRCUIT. Gaussot, D.; Brignon, P. (Electricite de France, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 71, 24-31(May-June 1968). (In French).

The design of the various components for the EDF-4 integrated primary circuit is described; these include the support plate and the core-skirt support. The primary heat exchanger is described in detail; cross sections show tube arrangement within the heat exchanger. The containment structure and coolant circulators are described briefly. (M.L.S.)

1990 RINGHALS [NUCLEAR POWER STATION]. Nucl. Eng., 13: 838-9(Oct. 1968).

The Swedish 750 MW(e) BWR power station which is described is similar to the 440 MW(e) station at Oskarshamm. The larger reactor will have a higher fuel rating, six primary loops instead of four, and two turbo-generators. (UK)

Power Reactor Development

Refer also to abstract 977

1991 (AI-AEC-12680) AEC UNCLASSIFIED PROGRAMS. Quarterly Technical Progress Report, January–March 1968. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 206p. Dep. CFSTI.

NEUTRON CROSS SECTIONS—evaluation of, development of automated procedures for
REACTORS, FAST—neutron flux spectra analysis of, development of methods for region dependent; physics analysis of, use of Monte Carlo methods for; safety analysis of, dynamics simulator development for; structural materials for, helium degradation effects on; fuel materials for, preparation and properties of mixed-carbide
LIQUID METAL FAST BREEDER REACTOR—Doppler reactivity measurements in, techniques for fast neutron spectrum; fission product behavior in sodium coolant of; effluent release and transport in primary-coolant-sodium fires in; sodium boiling characteristics in; noise analysis instrumentation development for
SODIUM—neutron spectra in large volumes of liquid, measurements of differential; boiling characteristics in LMFBR coolant channels; sampling procedures for impurity analysis in reactor coolant; solvent properties of liquid, for metals and non-metals
CRITICAL ASSEMBLIES—physics analysis of, use of Monte Carlo methods for
MONTE CARLO METHOD—use in fast reactor physics analysis
REACTOR SAFETY—analysis of fast reactor kinetics, dynamics simulator development for; sodium fires in LMFBR, aerosol release and transport following
FISSION PRODUCTS—behavior in sodium coolant of LMFBR
AEROSOLS—production in reactor primary-coolant-sodium fires, release and transport following
SODIUM REACTOR EXPERIMENT—retirement activities during Jan. to Mar. 1968
REACTORS, LIQUID METAL COOLED—sodium sampling procedures for impurity analysis in; structural materials fabrication and testing for; fuel cladding materials fabrication and testing for
REACTOR FUEL ELEMENTS—cladding materials for sodium-cooled, fabrication and testing of; cladding materials for fast, helium degradation effects on
LOOPS—operation of sodium dynamic, for testing fuel cladding
HEATERS—development of high-flux, for operation in sodium dynamic loop
HELIUM—effects of irradiation-induced, on tensile properties of fast reactor fuel cladding and structural materials
REACTOR FUELS—preparation and properties of mixed-carbide; stability of uranium carbide, effect of tungsten doping on irradiation; fabrication of mixed-carbide, melting and casting procedures for
PLUTONIUM CARBIDES—PuC–UC, preparation and properties of, for use as fast reactor fuel; PuC–UC, fabrication of fuels of, melting and casting procedures for
TUNGSTEN—effects on irradiation stability of uranium carbide fuels
URANIUM CARBIDES—stability of, effect of tungsten doping on irradiation
HALLAM POWER REACTOR—retirement activities during Jan. to Mar. 1968
FUSED SALTS—physico-chemical properties of, high temperature
METALS—chemistry of metal–metal salt solutions, high temperature; electronic structure of, relation of superconductivity and normal-state
SALTS—chemistry of metal–metal salt solutions, high temperature
ORGANIC COMPOUNDS—radiolysis of, physical-chemical processes in
ALLOYS—electronic structure of, relation of superconductivity and normal-state
RADIATION—effects on physical properties of crystalline solids by lattice defect production; effects on molecular structure of chromosomes, chemical changes from
SOLIDS—physical properties of crystalline, effect of irradiation induced lattice defects on
CHROMOSOMES—radiation effects on molecular structure of, mechanisms of chemical reactions in
FLOWMETERS—development of out-of-core, for LMFBR noise analysis. (H.D.R.)

1992 (BNWL-854) HEAVY WATER MODERATED REACTOR DESIGN STUDIES STATE-OF-THE-ART SURVEY. Wise, K. R.; Waddel, W. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 86p. Dep. CFSTI.

As part of the Heavy Water Reactor Program Office effort to define the "state-of-the-art" in heavy water moderated reactors, a survey of reactor designs and design studies was undertaken. The survey includes: (1) a list and description of the heavy water moderated power reactors either operating or under construction; (2) a list and description of the more recent design studies done on heavy water moderated reactors, with the exception of reactors using organic coolant; (3) a discussion of the various reactor types, as determined by type of coolant, indicating development trends; and (4) a discussion of various design features or characteristics that many heavy water reactors have in common, such as pressure tubes, on-line refueling, and D_2O loss rates. (32 references). (auth)

1993 (WASH-1101) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 1. OVERALL PLAN. (Argonne National Lab., Ill.). Aug. 1968. 240p. Dep. CFSTI.

The overall plan section of the LMFBR program discusses the organization and information presented in the nine other sections. These sections include: plant design, components, instrumentations and control, sodium technology, core design, fuels and materials, fuel recycle, physics, and safety. (auth)

1994 NUCLEAR REACTOR. Fiebelmann, Peter (to EURATOM). U. S. Patent 3,403,075. Sept. 24, 1968. Priority date Aug. 23, 1965, Germany.

A nuclear reactor is described having evaporization cooling and in which a reactor core is mounted in the bottom of a substantially vertical gas and pressure tight vessel. The vessel has a substantially cylindrical lower end and a cupola-shaped upper end. Means are provided to cool the cupola-shaped upper end from outside of the vessel. The inner surface of the vessel is provided with a capillary structure. Adjacent the reactor core a coolant medium is evaporated to again condense at the cupola-shaped upper end and returns, via capillary action, to the core. (Offic. Gaz.)

1995 EUROPEAN NUCLEAR INDUSTRY AND ITS MARKET. I. NUCLEAR POWER STATIONS AND POWER REACTORS. Pantleon, M. (Kommission der Europaeischen Gemeinschaften, Brussels). Atomwirt., Atomtech., 13: 370-3(July 1968). (In German).

Capital costs and investment capital for European power plants are tabulated. Planned and installed nuclear power plants are listed according to country and reactor type. Cost breakdowns are given for the various power plant components. Companies engaged in the construction of power plants and fabrication of the various components are listed according to country. (M.L.S.)

1996 ECONOMIC POTENTIALS OF ADVANCED REACTOR CONCEPTS. Boettcher, A.; Kraemer, H.; Wagemann, K. (Kernforschungsanlage, Juelich, Ger.). Atomwirtschaft, 13: 501-2(Oct. 1968). (In German).

In order to evaluate the economic potentials of different advanced reactor concepts the program developed by Harde/Memmert was used. The future annual power production cost within the Federal Republic of Germany was calculated for different combinations of power stations. In all cases conventional power stations and light water reactors were admitted. They were complemented at different dates by high temperature gas cooled reactors and different types of fast breeders. Within the limits of error of the input data for the different reactor lines the results show that high temperature gas cooled reactors with helium turbines, sodium cooled fast breeders with carbide fuel and helium cooled fast breeders with helium turbines have very similar economic potentials. By the early introduction of high temperature gas cooled reactors with steam- or helium turbines important savings are possible. Some evident conclusions for a development program are drawn from the results. (auth)

1997 NUCLEAR REACTOR PLANT. Kaegi, Jakob (to Sulzer Brothers, Ltd.). U. S. Patent 3,402,102. Sept. 17, 1968. Priority date June 25, 1965, Switzerland.

The steam generators are positioned below the shield block and are spaced about a central chamber which receives heated coolant gas from the nuclear reactor and distributes the heated

gas transverscly through the steam generators. The generators have pipes disposed horizontally to form heat exchanger surfaces with the heated coolant gas. (Offic. Gaz.)

1998 PFR: PRE-PRODUCTION REACTOR. Engineering, 206: 565-6(Oct. 18, 1968).

Construction methods are discussed and progress in construction is reported for the prototype fast reactor at Dounreay (UKAEA). (UK)

1999 NUCLEAR REACTORS. Walker, Alexander (to English Electric Co., Ltd.). British Patent 1,132,091. Oct. 30, 1968. Filed June 11, 1965.

A description of a concrete pressure vessel-enclosed graphite moderated gas-cooled reactor is presented. The core consists of multiple columns of graphite bricks with vertical fuel channels. Multiple standpipes in the pressure vessel provide fueling access to the core. Each graphite column is rigidly mounted to the base of the concrete pressure vessel by pedestals. The pedestals consist of hollow vertical tubes which provide coolant access to the fuel channels. Periphery support devices for the core are arranged to adjust to core size changes. (D.C.C.)

2000 NUCLEAR REACTORS. Dryland, Peter William; Pugh, Michael Charles (to United Kingdom Atomic Energy Authority). British Patent 1,131,076. Oct. 23, 1968. Filed Apr. 29, 1965.

A description of an integral pressurized-water reactor is presented. The reactor consists of a vertically elongate pressure vessel with the reactor core located in the lower end. The core consists of multiple fuel assemblies with respective control elements. The core is supported by an upper grid assembly and is positioned by a lower grid assembly. The fuel elements are attached to the upper grid by bayonet-type couplings with resilient locking devices. (D.C.C.)

2001 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Deighton, Thomas (to Babcock and Wilcox Ltd.). British Patent 1,131,102. Oct. 23, 1968. Filed July 6, 1965.

A description of a pressure vessel for an integral water-cooled reactor is presented. The pressure vessel consists of a cylindrical vessel with a main body portion and end portion. Each portion has a circumferentially extending flange. A ring positioned between the flanges provides conduits for heat exchanger access. (D.C.C.)

2002 NUCLEAR REACTORS. Mann, John Erskine; Barker, Allan; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,131,241. Oct. 23, 1968. Filed Feb. 12, 1965.

A description of a fast water-cooled nuclear reactor is presented. The coolant is subjected to supercritical pressure. The core consists of a fast fuel region, an encircling region of higher proportion of fertile to fissile material, and a zone extending from the interface of the regions which consists of Zr. Separate coolant passes are made through the fertile and Zr regions. (D.C.C.)

2003 CANADA TRIES A NEW APPROACH TO REACTORS BURNING NATURAL URANIUM. Strauss, Sheldon D. Power, 112: 92-3(Nov. 1968).

A description of the development program in Canada for heavy water-moderated and water-cooled boiling power reactors is presented. A comparison of the Canadian program with the U.S.A. water-cooled and -moderated reactor program is presented. (D.C.C.)

2004 SURVEY OF CONCEPTS OF PROTOTYPE FAST BREEDER REACTORS IN THE WORLD. Nakagawa, Hiroshi; Futami, Tsuneo (Tokyo Electric Power Co., Inc.). (Nippon Genshiryoku Gakkaishi, 10: 567-77(1968). (In Japanese).

A survey has been attempted of the current design concepts of prototype fast breeder reactors in the world, and they are classified according to their characteristics. The survey was focused on the trend of a closer interrelationship between each prototype and experimental as well as large commercial fast breeder reactor. (auth)

2005 DESIGN OF AN INTEGRATED HEAVY-WATER CO_2-COOLED REACTOR. Fonteray, J.; Martin, R.; Roche, R. (Commissariat a l'Energie Atomique, Saclay, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 72, 5-9(July-Aug. 1968). (In French).

A description of a heavy water moderated CO_2 cooled reactor contained in a single vessel is given. The advantages and disadvantages resulting from this integration are evaluated. Location of systems components such as heat exchangers, coolant circulators, and maintenance equipment is described. (M.L.S.)

2006 DEVELOPMENT OF PRESTRESSED CONCRETE VESSELS FOR POWER REACTORS. Schrage, H. P. (Univ., Essen). Tech. Mitt. Krupp. Forschungsber., 26: 77-82(Sept. 1968). (In German).

As capacities of nuclear power plants are increasing over 300 MW(e) to as much as 600 MW(e) and even more, prestressed concrete pressure vessels are becoming increasingly economical. Described are the physical requirements placed on such pressure vessels, as well as their development which, at Fried. Krupp GmbH Universalbau, has led to a special multi-layer design. (auth)

Kinetics and Dynamics

2007 (FEI-114) A COMBINED MODEL OF A NUCLEAR POWER PLANT FOR THE STUDY OF DYNAMIC CHARACTERISTICS. Selivanov, V. M.; Sidorova, I. I.; Karlov, N. P.; Gribanov, Yu. I.; Patrushev, Yu. K.; Shcherbakov, I. E.; Gorev, A. A. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1967. 11p. (In Russian). Dep.

A combined physical and electronic model is designed to simulate a two-circuit, steam-generating power plant with natural circulation of the heat-transfer agent in the first circuit and self-regulation of the power level by means of its negative reactivity coefficient. In view of the absence of an external automatic control, the dynamic characteristics of the reactor and of the overall system must be carefully studied. The geometric and thermophysical parameters and the heat-release rate of the model agree with the corresponding values of the real plant. A water-steam mixture is generated in the secondary circuit; the water is removed from the steam in the separator. The maximum electric power rating of the model is 200 kW. Changes in the flow rate of the coolant, pressure and temperature in various points can be recorded by means of the model. These dynamic studies make it possible to determine the stability of operations at various power levels. The model also makes it possible to study the effects of natural and forced circulation in one- and two-circuit systems. (TTT)

2008 (LA-3959) A NUMERICAL STUDY OF EXCURSIONS IN UHTREX LOADED WITH URANIUM-THORIUM FUEL ELEMENTS. Hopkins, George C. (Los Alamos Scientific Lab., N. Mex.). May 1968. Contract W-7405-eng-36. 6p. Dep. CFSTI.

A uranium-thorium loading has been proposed for the Ultra High Temperature Reactor Experiment (UHTREX). Calculations have been made for this loading for excursions resulting from step reactivity inputs of 20¢ to $2.00. The presence of thorium retards the transient significantly. (auth)

2009 (N-68-30369) THE SPHERICAL PILE REACTOR AS THERMAL THORIUM BREEDER. I. GRAPHITE AS MODERATOR. Brandes, S. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung). Translated from German report. 34p. (NASA-TT-F-11705). CFSTI.

The breeder characteristics of a graphite-moderated high temperature reactor of the spherical pile type for the $^{232}Th-^{233}U$ cycle are studied, investigation being conducted from the standpoint of minimum doubling times. Economic considerations are ignored. The BABS program (a burn-up program for a Th converter developed by the DRAGON project), expanded and improved for the design of breeder reactors (GABS program) was employed for calculations. (auth) (STAR)

2010 (ORNL-TM-2315) MEASUREMENT OF HELIUM VOID FRACTION IN THE MSRE FUEL SALT USING NEUTRON-NOISE ANALYSIS. Fry, D. N.; Kryter, R. C.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). Aug. 27, 1968. Contract W-7405-eng-26. 32p. Dep. CFSTI.

Investigations were made at the MSRE to determine if the amount of helium gas in the fuel salt could be measured using neutron noise analysis. The neutron power spectral density (NPSD) was measured at different reactor operating conditions and compared with analytical model predictions of the NPSD for the same conditions. The results of experimental tests and analytical studies have shown that the principal source of small neutron density fluctuation observed in the MSRE is He bubbles circulating in the fuel salt. The NPSD was most sensitive to changes in fuel temperature: the NPSD in the region of 1 cps increased by a factor of almost 50 when the average core outlet fuel temperature was decreased from 1225 to 1180°F. The measurements showed that NPSD in the frequency range from 0.5 to 2 cps varies as the square of He void fraction as predicted by the model, and that the minimum void fraction is more nearly zero than the previously accepted value of 0.1%. It is concluded that changes in the circulating void fraction can be inferred with good sensitivity directly from neutron noise measurements, and, consequently, NPSD can complement and enhance the value of the MSRE reactivity balance calculations. (auth)

2011 (RT/FI–(68)22) PHYSICAL FOLLOW-UP OF EBWR OPERATION BY NUCLEAR CODES DEVELOPED BY CNEN. 1st PART. ANALYSIS OF THE INITIAL CRITICAL EXPERIMENTS. Lopez, S.; Michelini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 40p. Dep.

Critical experiments in the Experimental Boiling Water Reactor with PuO_2-UO_2 fuel elements are being analyzed by calculations of the reactivity effects and of the power distribution in the core during burnup. The CNEN developed codes RIBOT, BOLERO, and BURNY for analysis of Pu-fueled boiling water reactors were used for calculations on the EBWR core. Calculated values are compared with experimental results, and some deficiencies in the calculational model are discussed. (H.D.R.)

2012 EXPERIMENTAL DETERMINATION OF THE BOILING REACTOR BK-50 FREQUENCY CHARACTERISTICS. Afanas'ev, V. A.; Sankovskii, G. A.; Gritskov, V. I.; Kebadze, B. V.; Sokolov, I. N. At. Energ. (USSR), 25: 179-84(Sept. 1968). (In Russian).

The techniques and results on the experimental determination of the reactivity-power frequency characteristics of the boiling reactor over a wide range of power and pressure values are described. The reactivity oscillation scheme obtained by using an ordinary servomechanism of the control and safety system and a brief description of the used equipment are presented. It is shown that it is necessary to introduce a correction into the amplitude-phase characteristic presentation. The question of obtaining reliable data for a high noise level, which is characteristic to a boiling reactor performance, is given a detailed consideration. The obtained experimental results show the peculiarities which from the point of view of the dynamics are typical to the boiling reactor. The expedience of widening the used frequency range is pointed out. (auth)

2013 EXPERIMENTAL INVESTIGATION OF SPATIAL EFFECTS ON THE NEUTRON FLUCTUATION SPECTRA OF A LARGE REACTOR. Buhl, A. R. (Univ. of Tennessee, Knoxville); Hanauer, S. H.; Baumann, N. P. Nucl. Sci. Eng., 34: 98-103 (Nov. 1968).

Experiments in a large zero-power graphite reactor indicate that simple-point reactor kinetics adequately describe the neutron fluctuation spectra everywhere except near the edges of the reactor. Near the edges, the break frequencies and rolloff slopes differ significantly, and anomalous irregularities in the distribution are observed. Computations explicitly for the large reactor, based on recently proposed theories, also agree excellently away from the edges, and fail to predict the measured spectra near the boundary. (auth)

Control Systems

2014 (WASH–1104) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 4. INST. AND CONTROL. (Argonne National Lab., Ill.). Aug. 1968. 351p. Dep. CFSTI.

The instrumentation and control section of the LMFBR program discusses the primary sensing elements needed for the measurement of: neutron flux; coolant sodium, clad, and fuel temperatures; sodium levels in tanks and vessels; flow in fuel assemblies and plant piping; pressure in reactor plenums, tanks, and vessels; and strain sensors for test surveillance on components, pipe, vessels, and fuel clad. The needs for the FFTF are considered. (auth)

2015 CONTROL CONCEPTS OF NUCLEAR POWER STATIONS. Jaschek, H. (Technische Hochschule, Munich). Atomwirtschaft, 13: 495-8(Oct. 1968). (In German).

The most important turbine and reactor control arrangements in nuclear power stations with pressurized water, boiling water and gas-cooled reactors are discussed. The nuclear power station Obrigheim serves as an example of a pressurized water reactor, the station Dresden-2 of a boiling water reactor and a power station with AGR as an example of a gas-cooled reactor. The pressurized water reactor is inherently controllable and for this reason it would be possible to do without an external control arrangement. However, for technological reasons a control is provided which backs up the self-regulating characteristics and limits the pressure build-up in the secondary circuit which accompanies self-regulation. Under full load operation the mean temperature of the cooling medium is held constant by an external control circuit. In addition the cooling medium pressure regulator and the rod reactivity control belong to the reactor control facilities. In the case of pressurized water reactors the formation of steam bubbles in the cooling medium is suppressed while it is permitted in boiling water reactors. The steam which feeds the turbine is therefore generated directly in the reactor. In the case of boiling water reactors the void coefficient, because of its strong repercussions on reactivity, plays a major role. The steam bubble volume is influenced by the reactor pressure and by the heat generation. Increasing pressure raises the reactivity and hence the power so that the pressure rises further. Thus for stable operation an external control arrangement is necessary. Adjustment of the reactor power is possible by control of the cooling medium through-put. An adjustment of the control rods is only necessary in the case of large power changes. The dynamic behavior of gas-cooled reactors is determined by the temperature coefficient of reactivity, by heat transfer and by the thermal capacity of the core. While the temperature coefficient of the fuel is always negative that of the moderator can be positive. The temperature of the moderator can, however, change only very slowly because of the large heat capacity of the graphite so that safe operation is possible even with large positive moderator temperature coefficients. (auth)

2016 TECHNOLOGY AND COSTS OF AUTOMATING NUCLEAR POWER STATIONS. Ditterich, K. (EURATOM, Ispra, Italy). Atomwirtschaft, 13: 503-8(Oct. 1968). (In German).

During the last few years two techniques have proved technologically and economically useful for the automation of technical processes: using digital computers; using function group units. The tendency is toward the use of digital computers, particularly for very extensive process controls such as are involved with nuclear power stations. It must not be forgotten, however, that function group technology with logic wired elements has also recently undergone a rapid development. Since both techniques, so far as the basic elements are concerned, are theoretically compatible developments in one mostly spread to the other also. It is precisely for this reason that no all-inclusive answer can be given to the question of which is the more appropriate technique for nuclear power stations. The possibilities for introducing digital computers into the automation of nuclear power stations are considered and contrasted with function group automation. The comparison shows that computer automation is indeed the most perfect kind but is also the most costly. In all known nuclear power stations automated by means of a computer a second similar computer is always installed as a reserve. In the case of automation by means of function units the expensive process computer is avoided but, on the other hand, the condensation into function groups and the division into planes is difficult and not always clear-cut. In weighing up the advantages and disadvantages of both systems the practicality emerges on purely economic considerations of combining both techniques for large nuclear power stations. Also the technical practicality of a concept based on a hybrid combination in which the lowest control plane consists of function groups and all higher planes are assigned to the computer can at least be demonstrated pragmatically. (auth)

2017 CONTROLLING NUCLEAR REACTORS. Raven, Anthony David (to English Electric Co., Ltd.). British Patent 1,131,103. Oct. 23, 1968. Filed Aug. 13, 1965.

A liquid metal-cooled reactor is described which has Li dispersed in the liquid metal coolant to add in reactivity control. The proportion of Li involved in the coolant is 1% by volume. (D.C.C.)

2018 CONTROLLING THE POWER OF A NUCLEAR REACTOR PLANT COMPRISING STEAM GENERATORS. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,131,547. Oct. 23, 1968. Priority date July 1, 1965, Germany.

A method for controlling a nuclear reactor is described. The method consists of controlling the boiler feedwater entry temperature. By varying the feedwater entry temperature with a heater the entry temperature of the coolant in the reactor is varied. The feedwater heater operates on tapped low pressure stage turbine steam. (D.C.C.)

Cooling Systems

2019 (CEA-R–3395) SODIUM PURIFICATION IN RAPSODIE. Giraud, Bernard (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Feb. 1968. 65p. (In French). Dep.

General features of the fast reactor RAPSODIE are described, and properties of the liquid Na coolant are reviewed. General principles of Na purification and impurity measurement are presented. The RAPSODIE Na purification system is described in detail and data obtained from operation during the first year are presented. (H.D.R.)

2020 (ORNL-TM–2297) HELIUM-COOLED NUCLEAR REACTORS. Trauger, D. B. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 24p. (CONF-681010–2). Dep. CFSTI.

From Helium Applications Symposium, Washington, D. C.

He-cooled high temperature nuclear reactors offer significant advantages in cost of power, conservation of nuclear fuels, safety and thermal efficiency. The advantages derive largely from the properties of He, particularly its small interaction with neutrons, chemical inertness, good heat transfer properties and optical transparency. Present technology for employing He as a coolant at high pressures together with experience from other gas-cooled reactors provides a broad basis for the development of large He-cooled nuclear power stations. The elements of gas-cooled reactors are described as they relate to He as the coolant. (auth)

2021 (WASH-1105) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 5. SODIUM TECHNOLOGY. (Argonne National Lab., Ill.). Aug. 1968. 362p. Dep. CFSTI.

The Na technology section of the LMFBR program discusses: interactions of liquid Na coolant with materials and impurities; measurement and control of impurities; and fundamental physical and chemical properties of Na systems. (auth)

2022 STEAM COOLED NUCLEAR REACTOR POWER SYSTEM. Wolfe, Bertram (to General Electric Co.). U. S. Patent 3,400,049. Sept. 3, 1968. Filed Jan. 11, 1967.

The conversion system for mass to thermal energy in a chain nuclear fission reactor is described. The system relates to a steam cooled nuclear reactor utilized as a heat source in an improved superheated steam power plant system in which highly superheated possibly contaminated steam from the reactor is cooled by indirect heat exchange with purified saturated steam to produce purified superheated steam and moderated by superheated contaminated steam which is purified by direct contact with water to produce the purified saturated steam. (Offic. Gaz.)

2023 STEAM COOLED NUCLEAR REACTOR POWER SYSTEM WITH STEAM DECONTAMINATION TREATMENT. Boardman, Charles E.; Schneider, Henry J.; Shoopak, Bernard F.; Wolfe, Bertram (to General Electric Co.). U. S. Patent 3,400,048. Sept. 3, 1968. Filed Jan. 11, 1967.

The conversion of mass to thermal energy in a steam cooled chain nuclear fission reactor is described. An improved system for steam generation and purification is described. Superheated steam contaminants are removed from wet saturated steam. The saturated steam is introduced into the nuclear reactor where it is superheated. (Offic. Gaz.)

2024 HEAT EXCHANGE MEANS IN A LIQUID-METAL COOLED NUCLEAR REACTOR. Barker, Allen (to English Electric Co., Ltd.). U. S. Patent 3,400,046. Sept. 3, 1968. Priority date Feb. 5, 1965, Great Britain.

In a liquid-metal cooled nuclear reactor in which the core and the primary heat exchangers are arranged in a reactor tank containing the reactor coolant, the heat exchangers are of a plate type in which the plates are in a continuously undulating form both transversely and longitudinally so as to consist of alternate concave and convex dimples and are so arranged as to permit parallel flow, the spaces between the plates for flow of reactor coolant therethrough being of constant width. (Offic. Gaz.)

2025 STUDIES ON CATALYTIC RECOMBINER FOR BOILING WATER REACTORS. II. CATALYTIC PROPERTIES PALLADIUM CATALYSTS SUPPORTED BY DOMESTIC ALUMINA. Murata, Toshifumi; Yusa, Hideo (Hitachi, Ltd., Tokyo). Nippon Genshiryoku Gakkaishi, 10: 561-6(1968). (In Japanese).

The catalytic activity and mechanical strength were measured on six kinds of alumina-supported palladium catalysts, with the view to finding a suitable domestic product applicable to catalytic recombiner for boiling water reactors. The effective chemical reaction rate constants k_e of the catalysts were determined by means of the rate equation presented in the previous paper, and the effect of k_e and of the geometric outer surface area a_s on the catalytic activity was discussed. Two of the domestic catalysts examined were estimated to attain catalytic activity comparable to that of Deoxo, by providing ample a_s. The mechanical strength of these domestic catalysts do not change in calcination below 600°C, and have been found superior to Deoxo. (auth)

2026 HEAVY WATER REACTOR WILL BOIL. Williams, A. (Ontario Hydro Nuclear Operations, Toronto). Power Eng., 72: No. 11, 78-80(Nov. 1968).

The Canadian NPD reactor is being converted to boiling heavy water heat transport to evaluate the design and to demonstrate the control and stability of such systems. Both the boiling and non-boiling systems are illustrated, and the advantages offered by the boiling system are discussed. (H.D.R.)

2027 TEMPERATURE FLUCTUATIONS IN A NON-EQUILIBRIUM SYSTEM. Saito, Keiichi (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 541-3(Oct. 1968).

The temperature fluctuations of a body immersed in a known temperature heat bath with a heat source are analyzed. A theoretical solution is presented. (D.C.C.)

2028 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. (to Sulzer Brothers Ltd.). British Patent 1,131,605. Oct. 23, 1968. Priority date Feb. 16, 1965, Switzerland.

A heat exchanger for a gas-cooled reactor is described. The heat exchanger consists of a tube bundle with a flowing second medium and a surrounding casing with a flowing first medium. The first medium has a divided flow at the end of the casing with part of the flow reversed back along the casing wall and the other part reversed through a tube along the tube bundle longitudinal axis. The shell is bell-shaped and the tube bundle longitudinal axis is vertical. (D.C.C.)

Fuels

Refer also to abstracts 351, 585, and 976.

2029 (AAEC/TM-470) FORTRAN IV PROGRAMS FOR COMPUTATION OF TEMPERATURE AND THERMOELASTIC STRESS IN A HOMOGENEOUS SPHERICAL FUEL ELEMENT DUE TO ARBITRARY HEAT TRANSFER VARIATION OVER THE SURFACE. Holy, Z. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1968. 30p. Dep.

Computer programs together with a brief outline of the theory are presented, which enable computation of temperature and thermoelastic stress fields in homogeneous spherical fuel elements due to arbitrary heat transfer variation over the surface. Uniform heat generation in the fuel element is assumed. (auth)

2030 (LA-DC-9807) ANALYSIS OF TEMPERATURES IN MOLTEN REACTOR FUEL TUBE BUNDLES. Axford, Roy A. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 37p. (CONF-681103-1). Dep. CFSTI.

From Annual Meeting of the ASME, Los Angeles, Calif.

The two-dimensional, fully developed temperature and velocity fields occurring in molten reactor fuel tubes in triangular tube bundles are analyzed on a coupled, multiregion basis. The three regions are the molten reactor fuel region, the tube wall region, and the coolant region. The molten reactor fuel is assumed to be in laminar flow, while the coolant is in either slug flow or laminar flow. Analytical results for the temperature and velocity fields of the three regions and the circumferential variations in the inside and outside tube wall surface temperatures, the tube wall temperature drop, and the inside and outside tube wall heat fluxes are presented. Numerical results show the dependence of these variations on the Prandtl-Grashof number product of the molten fuel region, the pitch-to-diameter ratio of the tube bundle, the ratio of the molten fuel thermal conductivity to that of tube wall, and the ratio of the tube wall thermal conductivity to that of the coolant. (auth)

2031 (NUMEC-3505-33) PuO_2-UO_2-ZrO_2 FUEL DEVELOPMENT PROGRAM. Progress Report, July 1-September 30, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). June 1968. Contract AT(30-1)-3505. 70p. (EURAEC-1967). Dep. CFSTI.

Work performed under United States-Euratom Joint Research and Development Program.

REACTORS, THERMAL — fuel development program for, operations during July to September 1967 for plutonium oxide (PuO_2)-uranium oxide (UO_2)-zirconium oxide (ZrO_2)

PLUTONIUM OXIDES PuO_2 — PuO_2-UO_2-ZrO_2, fuel development program for thermal reactors during July to September 1967; PuO_2-UO_2-ZrO_2, impurities in, effects of pellet compositions on chlorine and fluorine; PuO_2-UO_2-ZrO_2, microstructure of, effects of pellet composition and annealing time and temperature on; PuO_2-UO_2-ZrO_2, melting points for, effects of pellet compositions on; PuO_2-UO_2-ZrO_2, burnup of Type 347 stainless steel-clad pellet-shaped, analysis of 1.2×10^{20} fission/cm^3

CHLORINE, FLUORINE — impurities in plutonium oxide (PuO_2)-uranium oxide (UO_2)-zirconium oxide (ZrO_2) of, effects of pellet compositions on

REACTOR FUEL ELEMENTS — burnup of Type 347 stainless steel-clad plutonium oxide (PuO_2)-uranium oxide (UO_2)-plutonium oxide (ZrO_2) pellet-shaped, analysis of 1.2×10^{20} fission/cm^3

STAINLESS STEEL — cladding of Type 347, performance during burnup of plutonium oxide (PuO_2)-uranium oxide (UO_2)-zirconium oxide (ZrO_2) pellet-shaped fuel elements

REACTOR FUELS—development program for plutonium oxide (PuO_2)–uranium oxide (UO_2)–zirconium oxide (ZrO_2) thermal reactor, operations during July to September 1967 (D.C.C.)

2032 (NUMEC-3524-55) DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS. 13th Quarterly Report, April–June 1968. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Aug. 1968. Contract AT(30-1)-3524. 41p. Dep. CFSTI.

REACTORS, FAST—fuel development program for, operations during April to June 1968 for plutonium dioxide (PuO_2)–uranium oxide (UO_2)

PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fuel development program for fast reactors during April to June 1968 for; PuO_2–UO_2, impurities in, effects of plutonium oxide (PuO_2) ratio on cadmium, boron, and silicon; PuO_2–UO_2, fabrication of, effects of hammermilling and ballmilling on

CADMIUM, BORON, SILICON—impurities in plutonium oxide (PuO_2)–uranium oxide (UO_2) of, effects of plutonium oxide (PuO_2) ratio on

PLUTONIUM OXIDES PuO_2—fabrication of, description of oxalate process and air oxidation of metal

REACTOR FUELS—development program for plutonium oxide (PuO_2)–uranium oxide (UO_2) fast reactor, during April to June 1968 (D.C.C.)

2033 (ORNL-TM-2344) FUEL FABRICATION COST ESTIMATE FOR THE GE-LMFBR CONCEPT PRESENTED IN GEAP-4939. Goldman, A. E. (Oak Ridge National Lab., Tenn.). Nov. 1968. Contract W-7405-eng-26. 10p. Dep. CFSTI.

Fuel fabrication costs are estimated for a 1000-MW(e) fast, sodium-cooled, mixed-oxide-fueled reactor concept. The design incorporates BeO pins in a pancake core and vented fuel pins. Cost estimates are made for the core and axial blanket regions, with allowances for the fuel element geometries and complexities. Fabrication costs of $443 and $32.40/kg of core U + Pu are determined for the core and axial blanket requirements, respectively, for a 30-reactor industry, each 1000 MW(e). (auth)

2034 (ORNL-TM-2377) ECONOMICS AND TECHNOLOGY OF HTGR FUEL RECYCLE. Lotts, A. L.; Wymer, R. G. (Oak Ridge National Lab., Tenn.). Oct. 1968. Contract W-7405-eng-26. 55p. (SM-111/72; CONF-681008-1). Dep. CFSTI.

From Symposium on Advanced and High Temperature Gas-Cooled Reactors, Juelich, Germany.

The attainment of low power cost and high fuel utilization in high-temperature gas-cooled reactors (HTGR's) using the Th–^{233}U fuel cycle depend to a great extent upon the ability to economically recycle fuel. Accordingly, work is being conducted by the Oak Ridge National Laboratory and others to establish the technical requirements and economics for HTGR fuel recycle. The development effort, which is based on a fuel element having a pyrolytic C and SiC coated ^{233}U–^{235}U–Th fuel in graphite prismatic blocks, includes the development of processes and equipment for head-end processing, for chemical reprocessing, for sol-gel preparation of microspheres, and for refabrication of fuel elements. The ultimate objective is to furnish engineering data for the design and operation of a large commercial recycle plant. In addition, the recycle economics and the effects on economics of various alternatives in the recycle processes are being studied. The status of the recycle effort and projections of the cost of recycle HTGR fuel are described as well as the cost penalties associated with delay in recycling fuel in a growing HTGR economy. At present, the various processes are in the stage of laboratory development and conceptual design of pilot-scale equipment. The status of all steps in the recycle processes is discussed and the pilot facility, the Thorium–Uranium Recycle Facility (TURF), is briefly described. TURF has been constructed and is ready for installation of equipment for HTGR recycle work. The reference fuel design and the status of the work under way, including irradiation performance tests of coated fuel particles, are also discussed. (auth)

2035 (WASH-1107) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 7. FUELS AND MATERIALS. (Argonne National Lab., Ill.). Aug. 1968. 457p. Dep. CFSTI.

The fuel and materials section of the LMFBR program discusses the development of strong fuels and cladding. The developments required for near-term FFTF and demonstration reactors and long-term commercial LMFBRs are presented. (auth)

2036 (WASH-1108) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 8. FUEL RECYCLE. (Argonne National Lab., Ill.). Aug. 1968. 235p. Dep. CFSTI.

The fuel recycle section of the LMFBR program discusses the technology for fabricating fuel for the Fast Flux Test Facility and demonstration LMFBRs and for recovering fuel materials discharged from them, the technology for commercial LMFBRs sufficiently advanced that power costs will be competitive with those of LWRs and fossil-fueled plants, and lower fuel-cycle costs for the long range and continued progress toward achieving a short doubling time and high utilization of energy in natural. Operations included in fuel recycle are those between discharge of fuel from the reactor and the return of newly fabricated fuel assemblies to the reactor. (auth)

2037 DEPLETION ANALYSIS OF MULTI-ZONE FAST BREEDER SYSTEMS. Wolsko, Thomas David. Lafayette, Ind., Purdue Univ., 1968. 285p.

Thesis.

The breeding characteristics of a fast reactor were utilized to determine whether a single batch loaded core is a feasible refueling method. This fuel management method was examined for two irradiation limits (100,000 MWD/tonne and 200,000 MWD/tonne). A cylindrical reference design, which has a core height to diameter ratio of 0.2, was used. The central core (30 volume per cent oxide fuel, 50 volume per cent sodium, 20 volume per cent stainless steel) is surrounded by axial and radial blankets. The core is divided into six radial fuel zones of equal volume in which the fertile to fissile fuel ratio varies from 3.54 to 6.57. One-dimensional burn-up calculations were performed using an improved version of the diffusion theory program, MIXED SPECTRAL SIZZLE. Burn-up calculations were performed to analyze parameters, such as spatial power density peaking, uniform depletion of fuel elements, and minimization of reactivity changes. The improved accuracy of burn-up calculations using multiple cross section sets is also analyzed. Two methods of calculation were compared. A comparison of the two calculation methods shows differences in the power density distribution in the core and blanket. The single batch loaded core design was shown to be a favorable fueling method. Power density peaking was held to a maximum value of 1.25 in the radial direction. This is accomplished by using four fuel zones with different U to Pu ratios. An average burn-up of 95.5 per cent of the peak burn-up was achieved in the radial direction. The longer irradiation period (200,000 MWD/tonne) is the most economical of the two limits. Fuel cycle operating costs were about 0.40 mills/kwh for this limit as compared to 0.70 mills/kwh for the shorter period (100,000 MWD/tonne). A one and one-half foot radial blanket is more economical than a smaller one foot blanket for this reactor system. Differences are on the order of 0.05 mills and become progressively smaller as the fissile Pu price decreases. (Disser. Abstr.)

2038 POWER COST REDUCTION BY CROSSED-PROGENY FUELING OF THERMAL AND FAST REACTORS. Lang, L. W. (Douglas United Nuclear, Inc., Richland, Wash.). Nucl. Appl., 5: 302-10(Nov. 1968).

Uranium-233 is a more efficient fuel in a thermalized flux than either ^{235}U or ^{239}Pu. Its nuclear performance and value to thermal converter reactors would be further enhanced if the ^{233}U is produced free of ^{232}U and it is used to enrich natural or depleted uranium. Although it has been generally accepted that the fissile isotope produced in the blankets of the fast breeders will be Pu, clean ^{233}U could be produced by charging thorium rather than ^{238}U into the fast reactor blanket. Since the breeding gain does not appear altered significantly, the ultimate decision facing the breeding reactor operator will depend on the comparative revenue from the two fissile isotopes. The value of ^{233}U will exceed that of Pu during early periods of breeding reactor development. As the value of Pu increases, due to fast reactor demand, the worth of ^{233}U will also increase but at a slower rate. If the price of uranium is $12/lb, the worth of ^{233}U will exceed that of plutonium up to $22/g. (auth)

2039 EFFECT OF POWER CHANGES ON FISSION PRODUCT GAS RELEASE FROM UO_2 FUEL. Soulhier, R.; Notley, M. J. F. (Atomic Energy of Canada Ltd., Chalk River, Ontario). Nucl. Appl., 5: 296-8(Nov. 1968).

Sixteen days of high power operation following a prolonged low power irradiation resulted in the same percentage release of fission product gases as when the UO_2 fuel was irradiated at the high power level alone. The release of fission product gas during a prolonged low power cycle was not increased by previous irradiation at higher powers. (auth)

Auxiliary and Emergency Systems

Refer also to abstracts 349 and 1025.

2040 (LA-3794) TEST OPERATION OF A PROTOTYPE, SOLID-STATE, HELIUM PURIFICATION CELL. Clark, R. A.; Melton, B. J.; Winkelman, C. R. (Los Alamos Scientific Lab.,

N. Mex.). Jan. 30, 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Two solid-state He diffusers were tested and their performance was determined under thermal conditions, radiation exposure, and pressure gradients typical of a reactor cover-gas purification system. Essentially complete removal of impurities Ar, N_2, O_2, CH_4, H_2O, Xe, and Kr from He in a single pass through the diffusers was demonstrated. At operating temperatures above 400°C, H_2 was detected in He delivered by the diffusers. Measurements were made of He flow rates through the diffusers at temperatures from 250 to 500°C, and the diffusion constant was determined. The diffusers successfully operated for several hundred hours at maximum temperature without cooling to the tube bundle seal and with mechanical vibration of the diffuser at the seal flange. Test operation showed that the diffusers could be successfully used in a He purification system requiring high purity, simple and remote operation, and little maintenance. Recommendations are made for improvement of the quality and capacity of a diffuser. (auth)

2041 (WASH-1103) LIQUID METAL FAST BREEDER REACTOR (LMFBR) PROGRAM PLAN. VOLUME 3. COMPONENTS. (Argonne National Lab., Ill.). Aug. 1968. 437p. Dep. CFSTI.

The components technology section of the LMFBR program includes: design practices; engineering standards; analytical methods; fabrication methods; quality-assurance practices; installation; operation; and maintenance procedures. The components are: the reactor primary vessel; reactor loading machines; control rod drives; and primary and secondary coolant-transport systems. Developments for the FFTF components are also presented. (auth)

2042 ADVANCES IN NEUTRON FLUX MEASURING TECHNIQUES. Schruefer, E. (AEG-Telefunken, Frankfurt am Main). Atomwirtschaft, 13: 498-501(Oct. 1968). (In German).

The development of neutron ionization chambers into larger and smaller configurations is described. The larger, long, ionization chambers are arranged outside the reactor and should deliver a program proportional to the total power, uninfluenced as far as possible by the position of the control rod. The smaller ionization chambers are introduced into the core and give information on the neutron flux distribution there. Noise amplifiers working on the Campbell principle are suitable for connection to both types of chamber and achieve a practical compensation against γ radiation. The many neutron measurement points inside a reactor core are in themselves no essential help for operation. A process computer is required which collects, standardizes and processes the data for the operator. A computer program has been developed for boiling water reactors which helps to determine the time dependent, three dimensional neutron flux distribution. Events in the reactor core can be very much better comprehended and progressed with the computer. The measurement permits an increase in the power density and therewith a decrease in the fuel charge. Process computers are already elements of basic equipment for large boiling water reactors which are now under construction or being planned. (auth)

2043 THE RELIABILITY OF EMERGENCY POWER SUPPLY TO LARGE THERMAL POWER STATIONS, IN PARTICULAR TO NUCLEAR POWER STATIONS. Apelt, Ottomar (Siemens Aktiengesellschaft, Erlangen, Ger.). At. Strom., 14: 101-6(July-Aug. 1968). (In German).

A more reliable assessment of the dependability of emergency power supply to large thermal power stations is presented. The basis for the calculation of a "overall breakdown probability" is given by the quotients of the number of "faults occurring" to the number of "total possible faults" to all the apparatus involved in emergency current supply. The fault calculation is carried out by using the example of emergency power supply to a 600 MW nuclear power station, and the result is discussed. (auth)

2044 EUROPEAN NUCLEAR INDUSTRY AND ITS MARKET. 2. SAFETY CONTAINERS, REACTOR PRESSURE VESSELS, AND INTERNAL REACTOR COMPONENTS. Forster, D.; Pantleon, M.; Schumacher, K. (EURATOM, Brussels). Atomwirtschaft, 13: 512-16(Oct. 1968). (In German).

Reactor pressure vessels and safety containers are among the heaviest and most voluminous fitments of nuclear power stations. The long term behavior of the steels used for reactor pressure vessels under the different operating conditions is still to some degree uncertain and must still be explored for a longer time. The increase in power station capacity in the trend towards very large single units makes new concepts and developments necessary. In the case of safety containers development has proceeded from the classical principle of steel containment to new conceptions such as the pressure equalization system or the stressed concrete container. Stressed concrete also represents an essential further development in the case of reactor pressure vessels. All pressure vessels which have so far been built for water reactors in the European Community are constructed from forged parts. For larger reactors, even with steel containment, new manufacturing processes will be necessary. The reactor internal fittings in the case of water reactors cause no essential manufacturing difficulties. A survey lists important manufacturing firms in the countries of the European Community together with their main deliveries and questions of international collaboration and business concentrations are discussed. (auth)

2045 METHOD AND APPARATUS FOR INCREASING BURN-OUT HEAT FLUX IN REACTOR PRESSURE TUBES. Pon, G. A. (to Atomic Energy of Canada Ltd.). Canadian Patent 785,383. May 14, 1968.

In boiling water reactors where two phase coolant is used it is desirable that as high a temperature as is practical should be attained without "critical high flux" occurring. This is a rapid and sudden deterioration in cooling caused by the accumulation of the liquid phase on the inner wall of the pressure tube with mainly the steam phase in contact with the fuel elements. Prevention of critical heat flux is achieved by wrapping the fuel bundles with a series of split rings that spring out against the pressure tube wall to block the flow of water along the surface of the pressure tube and direct it toward the fuel element surfaces especially in the center of the bundle. The rings resemble automobile piston rings but are preferably made of zirconium alloy in the interest of neutron economy. They are spaced around the fuel elements at distances approximately equal to the element diameter. The outer circle of fuel elements in a bundle contains wear pads which fit into notches in the rings. (F.S.A.)

2046 INVESTIGATION OF SOME METHODS OF FAILED-FUEL-ELEMENT DETECTION IN WATER COOLED REACTORS. Strindehag, Ove. Goteborg, Chalmers Tekniska Hogskola, 1968. 24p.

Thesis.

A summary is made of the following subjects: burst can detection system utilizing combined fission gas monitoring and electrostatic precipitation; liquid surface electrostatic precipitator; fission product monitoring in water-cooled reactors by detection of hard gamma radiation; calculated absolute detection efficiencies of cylindrical NaI(Tl) scintillation crystals for aqueous spherical sources; Čerenkov detectors for fission product monitoring in reactor coolant water; optical reflectors for use in internal sample Čerenkov counters; photomultiplier tubes for low level Čerenkov detectors; burst can Čerenkov detector for operation at high pressure; fast fission product monitor; failed-fuel detection system; and calibration of the failed-fuel element detection system in the Agesta reactor. (Swed)

2047 DIESEL UNITS FOR NUCLEAR PLANTS. Power Eng., 72: No. 11, 82(Nov. 1968).

Engine starting and load acceptance tests are described for a diesel-electric generating unit to demonstrate the capabilities of such units in supplying emergency power following coolant-loss accidents in power reactors. (H.D.R.)

2048 NUCLEAR REACTOR. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,131,548. Oct. 23, 1968. Filed Aug. 8, 1966.

A description of an emergency coolant pressurizer for a pressurized-water reactor is presented. The coolant pressurizer has an integral heat exchanger which has radiation-controlled flow. Any condensed coolant in the heat exchanger is returned to the core by a collector. Valves regulate the coolant circulator inlet and outlet ducts. (D.C.C.)

2049 EFFECTS OF CORE SPRAY COOLING AT STATIONARY STATE AFTER LOSS OF COOLANT ACCIDENT. Yamanouchi, Atsuo (Hitachi, Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 498-508(Oct. 1968).

In order to determine the conditions under which core spray cooling can be effective after loss of coolant accident, spray cooling experiments have been conducted on a heater assembly at low heat fluxes corresponding to the decay heat following a reactor shut-down. A series of tests have been made at atmospheric pressure using two kinds of 36-rod heater assemblies (15 mm O.D. sheathed heaters arranged in 119 mm square channels, 1500 mm and 2500 mm heated length). The following results were obtained: the heaters are cooled either by water a film of water streaming down its surface or by fog-flow and radiation to surroundings; the rate of flow along any single rod did not generally deviate much from the value of the total channel flow rate multiplied by the ratio of cross sectional areas between single rod and total channel, but the smallest value was about 0.4 of this average; so long as the heat transfer surface is covered by water, the surface temperature is close to the saturation temperature; and the dry-out is

caused either by progressive evaporation of the falling film (applicable to the range of the channel flow rates up to 400 kg/hr at 20°C water) or by "choking" (or flooding) with the ascending flow of steam generated in the channel (range of the channel flow rates above 400 kg/hr at 20°C water). (auth)

Operation and Economics

2050 LOCATION AND REPAIR OF THE DFR LEAK. Matthews, R. R.; Henry, K. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). Nucl. Eng., 13: 840-44(Oct. 1968).

The NaK leak was indicated by a spark plug type detector in the section of the leak jacket containing the reactor vessel. Methods used for leak location included monitoring the leak jacket for coolant and for pressurized blanket gas, the use of tracers, and bubble noise measurement on pressurizing the leak jacket. The apparently erratic behavior of the leak, which caused considerable difficulty in its location, was later attributed to thermal distortion of the pipework while the reactor was on power. On removal of the suspect section, a crack was found in the area of a weld on one of the 4 in. dia outlet pipes. The cutting, welding, and inspection techniques involved in the repair of the section are described. Details are given of the organization of the operation which was completed in 11 months. (UK)

2051 STUDIES IN NUCLEAR POWER REACTOR OPERATIONS. I. OPTIMISATION OF RADIAL POISON DISTRIBUTION DURING FIXED FUEL OPERATION. II. CASH-FLOW STUDIES OF POWER REACTOR OPERATIONS UNDER TIME-VARYING, NON-EQUILIBRIUM MARKET CONDITIONS. Coates, David Ewing. Urbana, Ill., Univ. of Illinois, 1968. 328p.

Thesis.

An approach to optimization of nuclear power reactor operations using radial poison distribution as a control, and results for typical unit sizes (140 MW(e), 500 MW(e), and 1000 MW(e) of heavy-water moderated and pressurized-water reactors are described. The reactor dynamics are simulated by the Shanstrom–Benedict model. A highly flexible model is constructed to show the effect on corporate management of both environmental market and economic conditions, varying in time over the twenty-five year history of nuclear power units, and operating and design choices. Annual statements of cash flows show the requirements for funds which may arise, and indicate that considerable fluctuations in working capital may result from apparently straightforward engineering decisions. Results, in terms of both nuclear characteristics and cash flows, are presented for pressurized water reactors of 140, 500, and 1000 MW(e) unit sizes, five values of feed fuel enrichment eight sets of economic environmental parameters, and three fuel management cycles. (Disser. Abstr.)

Safety and Siting

Refer also to abstracts 10 and 465.

2052 (AEC-tr-6961) STUDY ON CHEMICAL REACTIONS BETWEEN URANIUM DIOXIDE, THE MOST ABUNDANT FISSION PRODUCTS, WATER AND SODIUM. Henzel, N.; Kleine-Tebbe, A. (Battelle Institut e.V., Frankfurt am Main (West Germany)). Translation of a German report. 97p. Dep. CFSTI.

Chemical reactions between UO_2 fuel, the main fission product elements with regard to quantity and radioactivity, and water and sodium coolants are investigated for temperatures between 1000 and 3000°K. The relevant reaction equilibria of such systems is calculated and graphically extrapolated to high temperatures beyond the region of known thermodynamic data. From the reaction potentials obtained and the estimated initial mole concentrations of the reactants, the amounts of thermodynamically stable reaction products are determined as a function of temperature. (70 references). (H.D.R.)

2053 (BNWL-885) NUCLEAR SAFETY QUARTERLY REPORT, FEBRUARY-APRIL 1968 FOR NUCLEAR SAFETY BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 115p. Dep. CFSTI.

CONTAINMENT SYSTEMS EXPERIMENT—experimental facilities of, modifications to; cesium aerosol generation by cesium hydroxide vaporization in
CESIUM—aerosol generation in Containment Systems Experiment
REACTOR SAFETY—coolant blowdown simulation tests, machine plotting of data from
REACTORS, WATER COOLED—coolant blowdown in, machine plotting of data from simulated
PRESSURE VESSELS—support structure failure on simulated reactor, during blowdown tests; stress analysis of simulated reactor, during blowdown tests
NOZZLES—stresses on pressure vessel, during simulated blowdown tests
FISSION PRODUCTS—removal of methyl iodide aerosols from reactor containment using hydrazine sprays
REACTOR CONTAINMENT SYSTEMS—methyl iodide removal from, effectiveness of hydrazine sprays for
METHANE, IODO-—removal from reactor containment systems using hydrazine sprays
HYDRAZINE—effectiveness of sprays of, for methyl iodide removal from reactor containment systems of
PIPES—crack detection in pressure, use of acoustic emission signal analysis for
ACOUSTIC EMISSION METHOD—use for crack detection in reactor pressure piping
TRANSDUCERS—development of high temperature lithium niobate, for acoustic emission analysis
RADIOACTIVE WASTES—fixation by conversion to phosphate glass, evaluation of test runs for; solidification of solutions of, spray calciner development for; leach rates from phosphate glass in water
GLASS—production of phosphate, for fixation of radioactive wastes
PLATINUM—corrosion by feed solution in radioactive waste phosphate glass fixation process
CALCINATION—spray equipment and procedures for radioactive waste solutions, development of
STAINLESS STEEL—corrosion of Type 304L and Type 310, by spray-solidified radioactive waste. (H.D.R.)

2054 (DOCKET-50312-1) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1, SACRAMENTO MUNICIPAL UTILITIES DISTRICT. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). Aug. 12, 1968. 106p. Dep. CFSTI.

The complete safety evaluation for the Rancho Seco Power Reactor, performed by the AEC Division of Reactor Licensing, is presented. (M.L.S.)

2055 (KE-68-4) DESIGN STUDY FOR EARTHQUAKE RESISTANT NUCLEAR POWER PLANT. (Kaiser Engineers, Oakland, Calif.). Jan. 1968. Subcontract No. 2963. 68p. Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

Earthquake effects on a hypothetical 1000 MWe pressurized water power plant are analyzed in detail. The proposed design concept is described; seismic loading mechanisms and design criteria are defined. Faulting effects and soil structure interactions are considered. Complete cost studies take into account structures and foundations, equipment supports and safety provisions, and embedding of structure. Alternative concepts, and future studies and tests are discussed. Finite element and dynamic analysis methods used in the evaluation are described and the basis for design criteria are detailed. Drawings are included. 11 references. (M.L.S.)

2056 (KFK-798) THE KARLSRUHE RESEARCH PROGRAM ON NUCLEAR AEROSOLS AND ITS RELATION TO THE PLUTONIUM HAZARD OF FAST SODIUM REACTORS. Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). July 1968. 16p. Dep.

The Karlsruhe Research Program on Nuclear Aerosols is directed at problems connected with the accidental activity release in Na-cooled fast breeder reactors. Discussed are the characteristics of activity release models, the role of aerosol formation in activity release, and the objectives of the Karlsruhe program. (H.D.R.)

2057 (NP-17649(Vol.1)) REACTOR SAFETY COURSE NO. 7, 23rd SEPTEMBER TO 18th OCTOBER 1968. MANUAL OF LECTURE NOTES. VOLUME 1. SECTIONS I TO V. (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). 482p. Dep.

The lecture notes attempt to provide the main data for the lectures and discussions to be held during the course covering the broad aspects of reactor safety. Volume 1 contains notes in an outline form on: reactor assessment and legal aspects; fission product release; containment engineering; control and instrumentation; and gas cooled reactors. (H.D.R.)

2058 (NP-17649(Vol.2)) REACTOR SAFETY COURSE NO. 7, 23rd SEPTEMBER TO 18th OCTOBER 1968. MANUAL OF LECTURE NOTES. VOLUME 2. SECTIONS VI TO IX.

(United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). 388p. Dep.

Notes in an outline form are included on: water reactor safety; fast reactor safety; siting policies and problems; and general aspects of reactor safety training, experimental techniques, and reporting procedures. (H.D.R.)

2059 (NYO-841-14) REACTANTS FOR THE REMOVAL OF IODINE AND METHYL IODIDE AND THEIR APPLICATION IN FOAMS. Viles, F. J. Jr.; Bulba, E.; Lynch, J. J.; First, M. W. (Harvard Univ., Boston Mass. Harvard Air Cleaning Lab.). Aug. 1968. Contract AT(30-1)-841. 29p. (CONF-680811-7). Dep. CFSTI.

From Symposium on Operating and Developmental Experience in the Treatment of Airborne Radioactive Wastes, New York.

The encapsulation of contaminated air by stable, reactive foams is potentially an efficient method for cleaning reactor containment system air because of large surface areas and long reaction times. Contained atmospheres encapsulated by foam demonstrate significant reductions in leakage. Addition of hydrazines to water-based foams provided high removal rates for elemental iodine. A 0.11 M concentration of unsymmetrical dimethyl hydrazine (UDMH) in foam resulted in iodine reductions of 99 and 99.97% within 12 and 18 minutes, respectively. Screening tests of reactive foam solutions for removal of gaseous methyl iodide were made under static and dynamic (shaking) conditions and included the following reactants: hydrazine, UDMH, piperazine, tri-n-butylphosphine (TBP), triethylenediamine and thioacetamide. In the dynamic tests, $\frac{1}{2}$ to $\frac{1}{4}$ molal concentrations of the latter three reactants in an alkaline foam solution containing $\frac{1}{2}$ molal UDMH required 7, 14, and 28 minutes, respectively, to reduce methyl iodide to 1% of the initial concentration (1 to 7 ppM). The other reactants were less effective by comparison. Water-foam encapsulation studies for air containing 0.8 to 2.0 ppM methyl iodide showed removal rates not significantly different from those found in the static screening tests for the same reactants; even though reactive surface areas were 20 to 100 times greater after foaming. This suggests that there is an absence of reactant in the foam bubble film probably caused by displacement by surfactants in the foaming agent. High removal rates of elemental iodine by hydrazine-type foams and of methyl iodide by TBP-containing foams are explained by noting that, in these cases, gas-phase rather than liquid-phase reactions are involved and that the foam bubble surfaces are collecting surfaces for the formed aerosol particles. (auth)

2060 SAFETY EVALUATION PROBABILITY METHOD FOR GCRs. Cave, L. Nucl. Eng., 13: 848-53(Oct. 1968).

The suitability for urban siting of the main variants of the AGR and HTR systems is investigated on the basis of the criteria proposed by Farmer [NSA 21: 31955]. The design characteristics which affect safety are identified, and the way in which possible variations would affect the frequency of primary faults and the seriousness of their effects is discussed. It is concluded that, in addition to the current AGR system, the variant most likely to be suitable is a homogeneous HTR with upward coolant flow, CO_2 coolant, a coated particle fuel with good fission product retention, and a CO_2 resistant container. (UK)

2061 RECOMMENDATIONS FOR THE DESIGN AND CALCULATION OF REACTOR VESSELS WITH A VIEW TOWARDS NUCLEAR SAFETY. Costes, Didier (Commissariat a l'Energie Atomique, Surete des Piles, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl), No. 72, 10-14(July-Aug. 1968). (In French).

The four classes of prestressed concretes which are used for reactor construction are listed; protection of prestressing tendons from corrosion is discussed. General safety features of nuclear vessels are outlined; the problems associated with use of concretes are described. A list of problems associated with the protection of the prestressing tendons is given; containment and circuit integration problems are discussed. (M.L.S.)

Power Conversion Systems

2062 WHICH KIND OF EXCHANGERS FOR LMFBR? Ford, J. A. (Atomic Power Development Associates, Inc., Detroit); Probert, P. B. Power, 112: 94-5(Nov. 1968).

Advantages and disadvantages of recirculating and once-through boilers for liquid metal-cooled fast breeder reactors are presented. Development efforts in the U.S.A. are presently focused on the once-through boiler. (D.C.C.)

Research and Test Reactors

Refer also to abstracts 514, 670, 1770, 1771, 1980, and 2156.

2063 (BNWL-SA-1694(Rev.)) OPERATION OF REACTOR SYSTEMS WITH A DIGITAL COMPUTER. Clark, R. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 31, 1968. Contract AT(45-1)-1830. 12p. (CONF-680601-42). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

A description of the High Temperature Lattice Test Reactor digital computer control system is presented. The system is referred to as the Programmed Measurement and Control System; and it consists of a control console, a PDP-7 digital computer, and an input-output interface section. Operational experience with the system is described. (D.C.C.)

2064 (IN-1248) A RE-EXAMINATION OF THE MTR GRAPHITE PEBBLE BED REFLECTOR. Fast, E.; Wheeler, V. G.; Cohen, S. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Dec. 1965. Contract AT(10-1)-205. 103p. Dep. CFSTI.

The MTR graphite pebble bed reflector stored energy distribution and thermal performance were re-examined. Results show that the pebble bed will not cause excessive structural temperatures or present a fire or radiological hazard because of any credible accident. (auth)

2065 (IN-1249) OPERATION EXPERIENCE WITH CAST IRON, CAST STEEL, AND CARBON STEEL IN DEMINERALIZED WATER. Bernhardt, J. J. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Apr. 14, 1966. Contract AT(10-1)-205. 15p. Dep. CFSTI.

Operating experience of the Engineering Test Reactor (ETR) and the Materials Testing Reactor (MTR) gives strong support for using carbon steel, cast iron and cast steel components in a demineralized water system. Cast iron pump cases have been used for 13 years in the MTR system and cast steel and carbon steel has been used in ETR for 9 years. Corrosion has not been excessive in either system nor has iron contamination been present in the water. (auth)

2066 (IS-1900, Paper 7) REACTOR DIVISION. Spedding, F. H.; Voigt, A. F.; McCorkle, W. H.; (and others) (Ames Lab., Iowa). 56p.

Activities are reported in: burnup determinations, refueling, and utilization of the Argonne Low-Power Research Reactor (ALRR); modifications to the ALRR; support for ALRR experiments; and research and general development projects. Modifications were made to the ALRR thermal shield system, top shield, D_2O filter cleanup system, rabit control system, and thermal power meter. The proposed ALRR safety system is described. Design and development and modifications for equipment and instrumentation used in ALRR experiments are summarized. Neutron flux measurements, neutron beam enhancement experiments, control rod worth and calibration measurements, fission product decay properties, neutron converter design, fuel element design, and safety studies are presented. (H.D.R.)

2067 (KFK-776) INVESTIGATION OF THE DEPENDENCE OF THE REACTIVITY OF A FAST GAS COOLED 500 LITER REACTOR ON THE GAS DENSITY IN SNEAK-3A. Engelmann, P.; Raberain, A. M.; Wintzer, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). May 1968. 41p. (In German). (EUR-3955). Dep.

A series of steam-void- and flood-experiments was performed in the U fueled SNEAK assemblies 3A-1 and 3A-2, in order to study the dependence on H_2 concentration of the reactivity in the range of $N_H = 0$ to $N_H = 3.6 \times 10^{21}$ cm^{-3}. A comparison of experimental data was made with calculations using the 26 group SNEAK set, SNEAK-PMB set, and ABN set, respectively. All calculations tend to underpredict the reactivity changes: both SNEAK-PMB and SNEAK set give reasonable values in the range $N_H = 0$ to $N_H = 1.8 \times 10^{21}$ cm^{-3} (working point); the maximum deviations are 5 and 15%, respectively. The flood reactivity is underestimated with these sets by 20 and 25%. The ABN set, however, underpredicts both void- and flood-reactivities by 30 to 35%. (auth)

2068 (NP-17579) ANNUAL SCIENTIFIC REPORT, 1967 [ON NUCLEAR RESEARCH]. Billiau, R.; Buyse, L.; Fredrix, H. (eds.) (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). 41p. (D-55/68). Dep.

Separate abstracts were prepared for twelve sections of this report. Progress is reported on various aspects of technological research on reactors, production of radioisotopes, basic research on physics and radiobiology, chemical and radioactive analyses, and waste processing. A list of 344 publications is included. (H.L.W.)

For abstracts of individual sections see: 15, 214, 348, 820, 821, 904, 963, 1515, 1825, 2069, 2070, and 2132.

2069 (NP-17579, pp I.1-60) TECHNOLOGICAL RESEARCH: REACTORS AND FUEL CYCLE. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

A description of operations at the BR2 Reactor during 1967 is presented. Performance of irradiated PuO_2-UO_2 fuel is described. Operations at the BR3/VULCAIN reactor and VENUS critical assembly during 1967 are described. Fast neutron spectra measurements are presented. Fabrication of pellet-type PuO_2 fuel elements for thermal reactor testing is described. Fabrication of PuO_2-UO_2 pellet-type fuel elements is also described. Fast reactor UC fuel fabrication is discussed. The tensile properties for ferritic steel canning materials are presented. (D.C.C.)

2070 (NP-17579, pp VI.1) BR1 REACTOR. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

A description of the irradiations performed in the BR 1 is presented. (D.C.C.)

2071 (ORNL-TM-2382) HIGH FLUX ISOTOPE REACTOR. Quarterly Report, April-June 1968. McCord, R. V.; Corbett, B. L. (Oak Ridge National Lab., Tenn.). Sept. 11, 1968. Contract W-7405-eng-26. 22p. Dep. CFSTI.

Operations and maintenance requirements performed for the HFIR during April to June 1968 are presented. Shutdown descriptions during this time period are also presented. (D.C.C.)

2072 (ORNL-TM-2386) OAK RIDGE RESEARCH REACTOR QUARTERLY REPORT, APRIL, MAY, AND JUNE OF 1968. Tabor, W. H.; Hurt III, S. S. (Oak Ridge National Lab., Tenn.). Sept. 4, 1968. Contract W-7405-eng-26. 38p. Dep. CFSTI.

Operating experience, instrument and process maintenance, and experiment activities during April to June 1968 are presented. (D.C.C.)

2073 (RCN-99) INCIDENT FOLLOWING FAILURE OF A FUEL IRRADIATION CAPSULE IN THE HFR, MAY 7, 1968. Snepvangers, J. J. M. (Reactor Centrum Nederland, The Hague). July 1968. 52p. Dep.

On May 7, 1968, a failure occurred in one of the fuel irradiation experiments, located in the poolside facility of the Materials Testing Reactor (HFR) at Petten, while the reactor was being brought to full power. Incorrect positioning of the experiment, which passed unnoticed during the reactor check-out before start-up, resulted in overheating of the fuel specimen. Melting of the fuel occurred and gaseous and volatile fission products were released in large quantities to the pool water. The incident and its causes, the actions which were undertaken after the incident, results of measurements on radiation and activity levels, released quantities of activity, and the experience gained from the incident are described. (auth)

2074 (RT/FI-(68)24) MEASURE OF REACTIVITY OF THE CONTROL RODS BY THE "ROD-DROP" TECHNIQUE. Farinelli, U.; Musco, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 32p. (In Italian). Dep.

The rod-drop technique was applied in order to measure large negative reactivities. Measurement methods, experimental performance, and some results of measurements on R.O.S.P.O. Reactor are described. The method was applied in order to evaluate interactions between control rods. (auth)

2075 (SC-DR-68-625) ANNULAR CORE PULSE REACTOR (ACPR) TRANSIENT HEAT TRANSFER MEASUREMENTS. Rivard, J. B. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. Contract AT(29-1)-789. 29p. Dep. CFSTI.

The transient heat transfer characteristics of the Annular Core Pulse Reactor (ACPR) are an important consideration in high temperature pulsing operation. Measurements and analysis of these characteristics at the 900°C peak-fuel-temperature level are presented. An adequate DNB margin for operation at 1000°C peak fuel temperature is reported, and the erroneous indications of cladding thermocouples are discussed. (auth)

2076 SPECTRUM OF GAMMA RAYS EMITTED BY A STAINLESS STEEL CLAD, POOL-TYPE REACTOR (BSR-II). Chapman, G. T.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 34: 169-80(Nov. 1968).

Measurements of the pulse-height distribution of γ rays observed as a function of position and angle in the water shield of the Bulk Shielding Reactor II, a water-moderated and water-cooled pool-type reactor with stainless steel clad fuel plates, have been transformed to γ ray energy flux spectra by a computer program which removed the effects of the spectrometer's non-unique pulse-height response and accounted for the energy variation of the spectrometer's efficiency. The results show that the photons above 5 MeV originate primarily from thermal-neutron capture in the components of the stainless steel. γ rays due to the ^{57}Fe component were identified as those known to be at 5.91, 6.02, and 7.6 MeV. Others were due to ^{58}Fe at 10.16 MeV, to ^{54}Cr at 8.88 and 9.72 MeV, and to ^{59}Ni at 8.53 and 8.99 MeV. Below 5 MeV the spectra consist of a strong contribution at 2.2 MeV from thermal-neutron capture in the H of the pool water, combined with a continuum presumably composed of prompt and delayed γ rays following fission, lower energy components in the capture spectra from the stainless steel, scattering in the reactor or shield, and other lesser sources. (auth)

2077 APPLICATION OF MATHEMATICAL PROGRAMMING IN THE DESIGN OF OPTIMAL CONTROL SYSTEMS. Tabak, Daniel. Urbana, Ill., Univ. of Illinois, 1968. 120p.

Thesis.

The possibility of applying mathematical programming techniques in the design of optimal reactor control systems is investigated. A general, nonlinear, nonautonomous control system is considered. A method of applying mathematical programming, in the optimization of this system, is formulated and its effectiveness is evaluated. A general, nonlinear, integral and terminal performance index, subject to nonlinear equality and inequality constraints is treated. Several problems involving computational use of mathematical programming methods are solved. The potential application of mathematical programming in the synthesis of optimal stochastic and adaptive control systems is also discussed. (TSS) (Disser. Abstr.)

2078 NEW EVALUATION OF THE PERFORMANCE OF A THERMAL AND COLD NEUTRON SOURCE TO BE USED IN A FAST PULSED REACTOR. Riccobono, G.; Fraysse, G.; Menardi, S. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 15: 721-5(Nov. 1968).

The time behavior of neutron pulses has been determined at single energies of 5, 20, 80 MeV following the injection of fast neutron bursts in some moderator configurations at room and liquid nitrogen temperatures. The results are discussed assuming that the moderator configurations considered are used as sources of thermal and cold neutrons when coupled to a pulsed fast reactor. (auth)

2079 EURACOS: AN IRRADIATION FACILITY WITH A HIGH FAST NEUTRON FLUX. Perlini, G. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 15: 697-701(Nov. 1968). (In Italian).

The EURACOS (Enriched URAnium COnverter Source) facility is essentially formed by a highly enriched uranium circular slab (90% ^{235}U), 80 cm in diameter, which uses the neutron flux released by the Ispra-1 reactor thermal column. It supplies a very intense fast neutron source ($\simeq 2 \cdot 10^{10}$ n cm^{-2} sec^{-1}), having an energy spectrum very similar to the fission spectrum. The converter is placed in front of an irradiation chamber (1.5 · 1.5 · 2.0) m^3 sized. Samples of any kind, also living samples, can be introduced in it, though EURACOS, for its peculiar structure, is particularly suitable for shielding studies. The facility already reached satisfactorily its full power; neutron flux trend and spectrum in the irradiation chamber have been investigated in it. (auth)

2080 TIME-OF-FLIGHT MEASUREMENTS OF THE NEUTRON SPECTRUM IN A SUB-CRITICAL FAST REACTOR ASSEMBLY. Coates, M. S.; Gayther, D. B.; Goode, P. D.; Tripp, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy, 22: 547-68(Sept. 1968).

The neutron energy spectrum at the center of a sub-critical Vera 7A assembly was determined by the time-of-flight method in the range 100 eV to 4.8 MeV using the Harwell 45 MeV electron linear accelerator to provide a pulsed source of fast neutrons. Analysis of the shape of the present spectrum is described. (D.C.C.)

2081 METHOD AND MEANS FOR CONTROLLING A NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,132,228. Oct. 30, 1968. Priority date Jan. 28, 1965, United States.

A description of a control system for the Argonne Advanced Research Reactor is presented. The control system consists of control elements with a center "black" region and top and bottom "gray" regions. The control elements have a length approximately three times the axial core height. (D.C.C.)

Rocket and Space Reactors

Refer also to abstract 534.

2082 (LA-3982) NEUTRON RESPONSE ANALYSIS IN PULSED COUPLED-CORE REACTORS. Hopkins, George C. (Los Alamos Scientific Lab., N. Mex.). Nov. 1967. Contract W-7405-eng-36. 8p. Dep. CFSTI.

In the Los Alamos Coupled Reactor Experiment, some oscilla-

tory deviations from the expected monotonic increase were observed in the rising portion of the passive core neutron density response. A generalized multigroup point kinetics model is employed to analyze the experiment. Several approximations with respect to the number of energy groups, the existence of a reflector, and the between-core neutron distribution function were studied. For some approximations, anomalies similar to those experimentally noticed were observed in the passive core response. (auth)

2083 (LA-DC-9642) USE OF HYBRID SIMULATION TECHNIQUES IN THE NUCLEAR ROCKET PROPULSION PROGRAM. Murray, Hugh S.; Milich, Charles P.; Springer, Thomas E.; Balcomb, J. Douglas (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 12p. (CONF-680925-1). Dep. CFSTI.

From Conference on Analog Computation and Hybrid Simulation, Saclay, France.

The hybrid analog-digital computer facility used to predict the dynamic behavior of nuclear rocket propulsion systems is described. The use of the facility for generation of heat exchange properties of the hydrogen propellant is illustrated. (H.D.R.)

2084 (N-68-28612) CAVITY REACTOR CRITICAL EXPERIMENT. VOLUME 2. Pincock, G. D.; Kunze, J. F. (General Electric Co., Idaho Falls, Idaho). May 31, 1968. 246p. (NASA-CR-72415; GESP-35(Vol.2)). CFSTI.

Cavity reactor critical experiments were performed at the National Reactor Testing Station. Described are experiments with a full gaseous core of UF_6 and the mockup experiments using sheet fuel. All the prior and current cavity reactor experiments were conducted using sheet fuel. The gaseous core experiments described were designed to evaluate the adequacy of the sheet fuel mockups. (auth) (STAR)

2085 (N-68-28813) STUDY OF FLUID DYNAMICS OF GASEOUS NUCLEAR ROCKETS. Quarterly Progress Report, Period Ending June 30, 1968. Lewellen, W. S. (Massachusetts Inst. of Tech., Cambridge). 1968. Contract NSR-22-009-288. 11p. (NASA-CR-95629; QPR-1). CFSTI.

A bibliography of 168 titles is presented which deals with confined vortex flows. Included are articles on vortex flow bounded in some manner by either a solid boundary or a closed streamline. The bibliography was compiled for a study on the use of vortex flows for fluid dynamic containment of a gaseous nuclear fuel. (STAR)

2086 (N-68-29503) INVESTIGATION OF GASEOUS NUCLEAR ROCKET TECHNOLOGY: CLASSIFIED PROGRAMS. Quarterly Progress Report, September 16–December 15, 1966. McLafferty, George H. (United Aircraft Corp., East Hartford, Conn. Research Labs.). Dec. 30, 1966. Contract NASw-847. 36p. (NASA-CR-95730; E-9100931-31; QPR-13-c). CFSTI.

A portion of the investigation of gaseous nuclear rocket technology is designed to have particular application to a vortex-stabilized engine concept which is based on the transfer of heat by thermal radiation from gaseous nuclear fuel held in position by the fluid forces in a vortex to seeded hydrogen propellant passing over the fuel region. Included in these programs are theoretical and experimental studies of the fluid mechanics of vortex flow to determine criteria for fuel containment and studies of the effect of the results of these investigations on the characteristics of full-scale engines. Tests at high Reynolds numbers were initiated using a vortex tube employing directed wall jets for injection of the simulated propellant. Preliminary results were obtained from the rotating-peripheral-wall stability experiments and from an analysis to determine the effect of several different variables (including the substitution of hydrogen for helium as a moderator coolant) on overall engine characteristics. An analysis was also completed which relates the various measures of time constant in a vortex tube to the fuel costs in a full-scale engine. (auth) (STAR)

2087 (N-68-29950) NEUTRONIC EFFECTS ON MODERATOR INSERTION IN FAST-SPECTRUM REACTORS. Mayo, Wendell (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1968. 18p. (NASA-TM-X-1614). CFSTI.

A study of the effects of insertion of YH into fast-spectrum reactors was conducted. Large, negative moderator temperature coefficients of reactivity that became more negative with increasing moderation were found. Partial or primary reactor control could be based on this temperature coefficient. An increase in the mean prompt-neutron lifetime and a decrease in the positive reactivity coefficients of volumetric compression were observed when moderator was added. Moderator addition, however, increases the core size and results in larger fast-neutron fluxes in the reflector, causing increased shield weight for compact nuclear spacepower systems. (auth) (STAR)

2088 (N-68-29973) NERVA XE-1 CONTROL DRUM ACTUATOR LOW-TEMPERATURE HYDROGEN TEST PROGRAM. Robinson, David J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). June 1968. 39p. (NASA-TM-X-52465). CFSTI.

To gain further confidence in actuator performance in the 30 to 80°K temperature range, a test program using gaseous hydrogen was conducted. For the test program, actuator performance was measured in terms of its ability to function in a closed loop positioning system. The results showed that the actuator tested, while in continuous operation, performed satisfactorily when subjected to step changes in temperature from ambient to the 30 to 80°K range. The step changes in temperature include lowering both the coolant gas temperature while holding the drive gas at ambient temperature, and lowering both the drive and coolant gas temperatures. The test program also showed, for the actuator tests, that if the actuator is locked in one position and then subjected to a step change in temperature to the 30 to 80°K range, performance after unlocking is erratic. (auth) (STAR)

2089 (N-68-30516) CHARACTERISTICS OF A SPACE-POWER NUCLEAR REACTOR WITH CONSIDERATIONS FOR VENTING OR CONTAINING GASEOUS FISSION PRODUCTS. Miller, John V. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1968. 57p. (NASA-TM-X-1631). CFSTI.

A study of a fast spectrum, liquid metal cooled reactor in which the gaseous fission products were either completely vented, completely contained, or partially vented from the fuel element, was performed. Although several areas were found in which insufficient data are currently available to accurately analyze the problem, the characteristic behavior of the various concepts was determined using fuel temperature, cladding strain, and nuclear criticality as limiting conditions. The analysis shows that the completely vented reactor is generally smaller than the other concepts. This size advantage decreases as the strength of the cladding increases and as the allowable fuel temperature decreases. (auth) (STAR)

2090 (N-68-30750) NEUTRONIC CALCULATIONS OF FUEL AND POISON DRUM CONTROL OF REFRACTORY-METAL, FAST-SPECTRUM, SPACE-POWER REACTORS. Westfall, Robert M.; Mayo, Wendell (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Aug. 1967. 24p. (NASA-TN-D-4709). CFSTI.

An analytical procedure was developed to evaluate drum control worths with one-dimensional, radial, discrete ordinate transport calculations. Two types of drum control were evaluated, one with fuel drums containing a heavy-metal reflector material, the other with poison drums containing BeO and B_4C. The one-dimensional procedure gave small-core drum control worths which agree with two-dimensional calculations to within 7 percent. The control response curves from two-dimensional calculations agree with $\sin^2(\theta/2)$ curve to within 15 percent. Poison control drum worths are sufficient for 40-centimeter-diameter cores. Fuel control drums are applicable to cores as large as 80 centimeters in diameter. (auth) (STAR)

2091 (SC-CR-68-3673) RADIOCHEMICAL ANALYSES OF $^{238}PuO_2$ COLLECTED ON IMPACTORS M-15, M-37, M-22, AND M-32. Holland, W. D. (Tracerlab, Richmond, Calif.). June 1968). Contract 48-6831. 36p. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

Radiochemical analyses were performed to inventory the ^{238}Pu collected on impactors M-15, M-37, M-22, and M-32 from arc tunnel tests of SNAP fuel particles simulating reentry. The results were combined with individual particle measurements, obtained by the hollow-star and electronic-counting techniques, to calculate the percentage of the total amount of Pu that was collected as particles with equivalent $^{238}PuO_2$ diameters smaller than 0.1μ. In addition the weight percentage of radioactive particles in the larger size ranges collected on each impactor was determined. (auth)

2092 (UCRL-71206) THE ANALYSIS OF ADVANCED FAST SPECTRUM HEAT SOURCES FOR SPACE APPLICATION. McCauley, Edward W.; Brown, Norman J. (California Univ., Livermore. Lawrence Radiation Lab.). July 9, 1968. Contract W-7405-eng-48. 5p. (CONF-681101-3). Dep. CFSTI.

From International Conference on the Constructive Uses of Atomic Energy, Washington, D. C.

The outer radii of two alkali metal cooled reactor types for space application are examined to determine their minimum practical size in the near MW(t) range. Both types employ UN-

fuel, W-alloy cladding and structure, a W-clad Ta-alloy vessel, and operate at 1500°K. One is cooled by sodium heat pipes and is $^{233}U/^{235}U$ fueled. The other is convectively-cooled by lithium and is uniformly fueled with ^{233}U. The analysis indicates that heat pipe reactors are competitive with convectively-cooled reactors in this size and temperature range. (H.D.R.)

2093 GAS CORE REACTOR PROPULSION SYSTEM. Hunter, Henry M.; Bussard, Robert W. (to TRW Inc.). U. S. Patent 3,399,534. Sept. 3, 1968. Filed July 14, 1965.

An intergalactic propulsion system utilizing a gas core reactor to preheat the propellant before being expelled through a suitable nozzle is described. Mixing of the propellant fuel and the fissioning gas core is prevented by causing the propellant fuel to be discharged into the reactor chamber in a parallel coaxial stream about the fissioning gas fuel at substantially constant pressure and substantially constant axial velocity along the reactor length, the fissioning gas fuel being separate and recycled, whereas the heated propellant gas is expelled as thrust through the nozzle. (Offic. Gaz.)

2094 COMPUTATIONAL ASPECTS OF OPTIMAL CONTROL WITH APPLICATIONS TO A NUCLEAR ROCKET REACTOR. Price, Harold J. Albuquerque, N. Mex., Univ. of New Mexico, 1968. 135p.

Thesis.

Several methods for the numerical calculation of optimal controls are considered with a view toward the calculation of the optimal controls for startup of a nuclear rocket reactor. The nuclear rocket reactor is approximated by the classical one-lump, spacially-independent, neutron kinetics equations coupled to a one-lump, heat transfer process. The thrust of the nuclear rocket reactor is obtained from the reactor force of hot H_2 gas exhausting through a suitable nozzle. It is assumed that the controls for the nuclear rocket reactor are reactivity and H_2 flow-rate. The optimization problem is defined by requiring that the amount of H_2 consumed in transferring the reactor from a low power condition to a high power condition be minimal. For safety, mechanical and other physical considerations, inequality magnitude constraints are imposed on power level, temperature, temperature-rate-reactivity, reactivity-rate, and hydrogen flow-rate. Two theoretical methods to obtain solutions to optimal control problems are briefly discussed. These methods, dynamic programming and the maximum principle, are unable to provide closed-form solutions to the nuclear rocket reactor problem. In spite of this fact, theoretical considerations are used to provide information concerning potential singular solutions interior to the state-constraint boundaries. The conclusion is reached that on those portions of an optimal trajectory interior to these boundaries, the optimal startup of a nuclear rocket reactor is a maximal effort process. (Disser. Abstr.)

Process Heat and Desalination Reactors

2095 TRENDS IN DESALINATION. Nucl. Eng., 13: 854-8(Oct. 1968).

A short review is presented of 13 different methods in use or under consideration. Lines of development, project proposals, cost studies, and nuclear aspects are surveyed. (UK)

Marine and Portable Power Reactors

Refer also to abstract 1011.

2096 (BNWL-851) PHOENIX FUEL EVALUATION IN A MARITIME REACTOR DESIGN. Wise, K. R.; Jenquin, U. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 38p. Dep. CFSTI.

The Consolidated Nuclear Steam Generator-II reactor concept was used as a reference design to compare fuel cycle costs for Pu fueled cores with a high ^{240}Pu content (Phoenix fuel) to costs for an enriched U base case core. The Phoenix fuel was found to be competitive with the slightly enriched U reference fuel. Results are presented in graphical and tabular form, and the results and calculational methods are discussed. (H.D.R.)

2097 (TID-24753) NOBLE GAS RECOVERY STUDY MARITIME NUCLEAR SHIP SAVANNAH. Final Report. (Air Reduction Co., Inc., New York. Airco Industrial Gases Div.). Apr. 5, 1965. 65p. Dep. CFSTI.

The feasibility of recovering radioactive purge gas from the nuclear reactor containment compartment on the Nuclear Ship Savannah is investigated. In the event of a maximum credible accident, radioactive Kr and Xe could be released. Therefore, the development of a fission gases removal system is desired for the exhaust of the ship for up to a two-day period. A containment system which would store the fission products indefinitely is also desired. The preliminary engineering details and design criteria necessary for the preparation of final design drawings and the construction of the proposed unit are presented. (auth)

2098 (TID-24753(App.)) NOBLE GAS RECOVERY STUDY MARITIME NUCLEAR SHIP SAVANNAH. Final Report. (Air Reduction Co., Inc., New York. Airco Industrial Gases Div.). [1964]. 108p. DTIE.

Calculations and drawings required for the conceptual development of a fission gas removal and containment system for the Nuclear Ship Savannah are presented. (D.C.C.)

2099 ON THE SAFETY OF THE FIRST NUCLEAR-POWERED SHIP: A REPORT OF THE COMMITTEE ON EXAMINATION OF REACTOR SAFETY. Genshiryokusen, No. 51, 1280-91(Jan. 1968). (In Japanese).

The report by the Reactor Safety Inspection Committee to the AEC, concerning the safety of the first nuclear-powered ship, is given. The contents of the report include the following: an outline of the construction program (nuclear-powered ship and its land facilities); safety measures (ship hull, reactor plant, land facilities); evaluations of normal radiation doses (ship, land facilities); various possible accidents (ship, reactor, land facilities); and hazard evaluations and matters of distance in connection with hazards. (NSA of Japan)

2100 INTEGRAL NUCLEAR REACTOR-STEAM GENERATOR ARRANGEMENT. Purdy, David C. (to Babcock and Wilcox Co.). U. S. Patent 3,394,051. July 23, 1968. Filed Dec. 20, 1965.

A nuclear reactor-steam generator arrangement is described wherein the reactor core, the primary coolant fluid and the steam generating tube bundle are contained within a common pressure vessel. A hollow member surrounding the core defines with the inside of the vessel an annular space occupied by the tube bundle. Primary coolant is circulated by a pump upwardly through the hollow member to extract heat from the core, into the annular space through an upper opening in the hollow member, and downwardly through the annular space to transfer heat to feedwater flowing through the steam generating tubes to generate superheated steam. To minimize overall height and yet allow normal operation when the pressure vessel is subjected to pitch and roll deviations from a vertical attitude, the tube bundle extends in elevation from approximately the lower end of the reactor core up to a position within the primary coolant vapor phase zone in the upper portion of the vessel above the primary coolant liquid level. The primary coolant liquid level is regulated so that those portions of the steam generating tubes wherein nucleate boiling occurs will not be exposed to the primary coolant vapor phase, and the amount of tube heat absorbing surface exposed to the vapor phase will remain substantially constant under pitch and roll conditions. (Offic. Gaz.)

Production Reactors

Refer to abstract 325.

Reactor Theory

2101 (AEEW-M-825) GMS 3: A USERS MANUAL FOR IMPROVED GENERALISED MULTIGROUP SCHEME USING WDSN MK2 FOR THE KDF9 COMPUTER. Barnett, M. R.; Ward, J. A. (Atomic Energy Establishment, Winfrith (England)). Aug. 1968. 34p. Dep. CFSTI. UK 5s. 0d.

GMS 3 is an extension, written for the KDF9 computer, of the reactor physics program GMS 1. An improved DSN routine has been incorporated, with consequent reduction in running time in many instances. Three alternative nuclear data libraries are now available, the latest of these being entirely consistent with that of WIMS. A treatment of neutron streaming in simple voids is incorporated in the routine which prepared few-group macroscopic parameters. Details of theory and programming are included. (auth)

2102 (AI-AEC-Memo-12735) ATOMICS INTERNATIONAL REACTOR COMPUTATIONAL SYSTEM. Blaine, R. A. (Atomics International, Canoga Park, Calif.). Aug. 30, 1968. Contract AT(04-3)-701. 44p. Dep. CFSTI.

An open ended computational system for reactor design and analysis is described. The CAESAR, CLIO-II, EXPERT, AILMOE, and GRISM programs are presently incorporated into the system, and they can be run individually or in any combination. An iterative

calculation of region dependent spectra is used to illustrate the capability of the system. (H.D.R.)

2103 (BNWL-875) SURVEY OF REACTOR-NOISE TIME-ANALYSIS METHODS. Pacilio, N. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1968. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

Brief descriptions of techniques related to the reactor fluctuations in the time domain are presented. The techniques described include: methods based on time correlation analysis among the pulses; methods based on analysis of the moments of the distribution (n_j); methods based on differential analysis of the distribution (n_j); and methods based on correlation analysis among the signs of the fluctuations of n_j around its mean value. (D.C.C.)

2104 (CEA-R-3518) TABLES OF FORMULAE FOR CALCULATING THE MECHANICS OF STACKS IN GAS-GRAPHITE REACTORS. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug. 1968. 192p. (In French). Dep.

Formulae are presented for the mechanical effects due to strains, thermal or otherwise, on graphite moderator blocks surrounded or supported by steel structures. Equations were established from experiments made with large pile models at CHINON. The formulae can be used to calculate displacement strain, and stress in EDF-type stacks with a horizontal triangular block lattice. (TSS) (auth)

2105 (KAPL-P-3460) FLUX DEPRESSION IN A PARALLEL ARRAY OF CYLINDRICAL ABSORBERS. Crawford, Bruce W.; Friedman, Jack P.; Hansen, Eric C.; Judge, Frank D. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 24p. (CONF-680601-33). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

The flux depression within an absorbing medium of an infinite array of infinitely long purely absorbing parallel cyclinders is calculated. In order to account for the flux depression in this parallel array of cylindrical absorbing regions in few-group diffusion theory calculations, appropriate one-dimensional P, blackness-theory parameters are used. Results show that the self-shielding of an absorbing slab region may be drastically altered by rearranging the absorbing region in the form of an array of cylinders. (D.C.C.)

2106 (N-68-29886) NAC: NEUTRON ACTIVATION CODE. Weinstein, Suzanne T. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1968. 49p. (NASA-TM-X-52460). CFSTI.

Neutron activation code (NAC) is a computer code designed to predict the neutron induced gamma ray radioactivity for a wide variety of composite materials. This code is a subset of the NAP code, and the code output has been altered to provide convenient analysis by experimenters. The NAC output includes the input data, a list of all reactions for each constituent element, and the end of irradiation disintegration rates for each reaction. The code also compiles a product isotope inventory containing the isotope name, the disintegration rate, the gamma-ray source strength, and the absorbed dose rate at 1 meter from an unshielded point source. The induced activity is calculated as a function of irradiation and decay times; the effect of cyclic irradiation can also be calculated. (auth) (STAR)

2107 (WAPD-TM-804) MEASUREMENTS OF NEUTRON FLUCTUATIONS, ABSOLUTE DETECTOR EFFICIENCY, AND NATURAL NEUTRON SOURCE STRENGTH IN A LATTICE OF SLIGHTLY ENRICHED UO_2 RODS IN LIGHT WATER. LSBR/LWBR Development Program. Harris, D. R. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1968. Contract AT(11-1)-Gen-14. 28p. Dep. CFSTI.

Measurements of neutron fluctuations have been made on a lattice of slightly enriched UO_2 fuel rods in light water. A ^{99}Mo activation measurement provided the absolute efficiencies of the three neutron counting channels employed. Fluctuations are found to be substantially larger than predicted by a simple model ignoring spatial effects and delayed neutrons. Large reactivity changes were monitored by changes in degree of fluctuations. The effects of large counting losses on the measured dispersion parameter, Y, were determined. The natural neutron source strength in the reactor was measured to be 1.53 ± 0.15 neutrons per second per kgm of U. (auth)

2108 CONDITIONAL PROBABILITY METHODS IN REACTOR NOISE ANALYSIS. Szechter, A.; Chwaszczewski, St.; Mikulski, A. T. (Inst. of Nuclear Research, Swierk, Poland). Nukleonik, 11: 240-4(Sept. 1968).

Several noise techniques based on the measurement and the analysis of the time-dependent neutron count conditional probabilities are discussed. The methods presented enable the prompt neutron period to be efficiently determined in various reactor systems and over a wide range of reactor states. (auth)

2109 ON THE REALITY OF EIGENVALUES FOR BARE, HOMOGENEOUS REACTORS IN THE MULTIGROUP DIFFUSION THEORY MODEL. Froehlich, R. (Gulf General Atomic Inc., San Diego, Calif.). Nukleonik, 11: 255-7(Sept. 1968).

It is established that all the eigenvalues of a steady state bare reactor problem in the multigroup diffusion theory model are real, whenever the fission transfer matrix has a multiplicative form ($\chi^g \nu\sigma_f^{g'}$). The scattering matrix and the number of groups can be arbitrary. If the fission transfer matrix is nonmultiplicative (χ dependent on g and g', or in case of included (n,2n) reactions), then the eigenvalues are not necessarily all real, as was shown by a realistic counterexample. Plausible reasons are given that the eigenvalues are always close to the real axis. (auth)

2110 MONTE CARLO TECHNIQUE TO SOLVE. THE STATIC EIGENVALUE PROBLEM OF THE BOLTZMANN TRANSPORT EQUATION. Lieberoth, J. (INTERATOM, Bensberg, Ger.). Nukleonik, 11: 213-19(Sept. 1968).

A special Monte Carlo technique to solve static eigenvalue problems in the neutron transport theory is proposed. In the framework of the generation method, the neutrons can be weighed so that even for large reactors bias can practically be avoided, even when employing small neutron populations. Additionally, the transformation $\nu\Sigma_f/\nu_0 \rightarrow \Sigma_f$; $\nu_0 \rightarrow \nu$ is used to reduce the bias further. (auth)

2111 ENERGY DEPENDENT DIFFUSION LENGTH PROBLEM WITH TRANSVERSE LEAKAGE. Williams, M. M. R. (London Univ.). Nukleonik, 11: 219-28(Sept. 1968).

A complete mathematical analysis of the diffusion length problem in a finite slab system is presented. Assuming exponential decay in the axial direction, the corresponding diffusion length as a function of absorption and transverse dimensions is studied. Expressions are obtained for the extrapolated endpoint associated with a transverse buckling, and the variation of this with buckling. Assuming a simple model of scattering, the angular energy spectra in slabs of beryllium and graphite are obtained; interesting directional effects are observed. In particular, there is a predominance of cold neutrons in the forward direction, which increases as the buckling is increased, and a depletion of cold neutrons in the transverse direction, which increases as the buckling is increased. The latter phenomenon is an example of an angularly dependent diffusion cooling effect. (auth)

2112 STABILITY OF NUCLEAR REACTOR KINETICS EQUATIONS BY MEANS OF LIAPUNOV'S DIRECT METHOD AND ITS RECENT EXTENSIONS. Di Pasquantonio, F. (ENEL, Milan). Nukleonik, 11: 244-51(Sept. 1968).

The classical mathematical model of a nuclear reactor characterized by N groups of delayed neutrons and M temperatures is such that all solutions starting in the set $G: n > 0, c_i > 0$ for $t = 0$ remain in G for all $t > 0$. The differential system corresponding to this model has, in general, two singular points and one of these, the origin, belongs to the boundary of G. Since the Liapunov-like theorems, in general, are not valid when the equilibrium point belongs to the boundary of the region where the equilibrium is considered, for stability analysis of this type of system it is very useful to apply the new LaSalle theory, which is also valid when there are equilibrium points belonging to the boundary of G. Moreover this theory does not require conditions of definiteness on V and $\dot{V}$ and it is sufficient that $\dot{V}$ only does not change its sign on G. It is shown that several previous applications of Liapunov's direct method to nuclear reactor kinetics equations, independently of exactness of conclusions, do not follow from Liapunov's classical theorems; and that by means of extensions of Liapunov's direct method, the rigorous proofs of the applications considered are presented. Particularly it is shown that some functions given by Smets are not Liapunov functions in the classical sense, but are Liapunov functions in the sense of LaSalle. (auth)

2113 REACTOR NOISE ANALYSIS BY ANALOGUE COMPUTER TECHNIQUES. Bouzyk, Jacek; Ciechanowicz, Wieslaw; Filipczak, Wieslaw; Latek, Stanislaw (Inst. of Nuclear Research, Warsaw). Nukleonika, 13: 815-26(1968).

The autocorrelation functions for critical and subcritical zero power are evaluated. The medium size, general purpose analogue computer is used for on-line measurements. No special instrumentation is incorporated. The results obtained by the analogue computer and photo-tape techniques are compared. Two programmes for digital computer were written for experimental data processing. (auth)

2114 COMPUTING METHODS IN REACTOR PHYSICS. Greenspan, H.; Kelber, C. N.; Okrent, D. (eds.). New York, Gordon and Breach, Science Publishers, 1968. 598p.

The development of numerical analysis and computation in the field of reactor physics is presented in sufficient detail that the reader may gain an understanding of the fundamental methods used in solving the problems and the nature of the solutions themselves. Topics treated in separate chapters are: one dimensional diffusion theory, computation procedures for two- and three-dimensional diffusion theory, the discrete ordinate and spherical harmonics methods in transport theory, the treatment of the Boltzmann transport equation by Monte Carlo techniques, reactor kinetics calculations in time-dependent or time- and space-dependent systems, computation of the space and time history of reactors undergoing explosive disassembly, and mathematical concepts and problems underlying the application of the linear Boltzmann transport equation. Emphasis is given to why and how a computer code is built in a certain way to solve certain problems rather than presenting a specific example of the code itself. References are included within each chapter for representative codes. (H.D.R.)

2115 SPACE-ANGLE ENERGY-TIME-DEPENDENT NEUTRON TRANSPORT IN A HOMOGENEOUS SLAB BY THE j_N METHOD. Asaoka, T. (EURATOM–CCR, Ispra, Italy). Nucl. Sci. Eng., 34: 122-33(Nov. 1968).

The j_N method is applied within the context of a multigroup model to solve neutron transport problems for an infinite homogeneous slab with finite thickness under the assumption that the scattering of neutrons is spherically symmetric in the laboratory system. Stationary space-angle energy-dependent problems are treated as a special case of time-dependent problems. The numerical results for the vector flux generated by a stationary boundary source show that the j_5 approximation gives an accuracy comparable to the S_8 approximation in Carlson's theory, regardless of the size of the system. The transient time behavior of leakage neutrons is calculated on the basis of a one-group model and compared with Monte Carlo results. The j_7 approximation gives values which agree well with those of the Monte Carlo calculation. In addition, the leakage neutron fluxes from copper blocks are obtained by the use of a 7 group j_7 approximation as a function of time and the decay constants are compared with the experimentally observed values. (auth)

2116 SOLUTION TO THE NEUTRON TRANSPORT EQUATION FOR AN INFINITE CYLINDER BY FOURIER SERIES. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 34: 134-47(Nov. 1968).

Approximate solutions to the one-velocity neutron transport equation for an infinite cylinder with isotropic scattering and spatially piecewise constant cross sections are obtained by Fourier expansion of the neutron distribution function in one of the angular variables. An infinite coupled set of equations for the expansion coefficients is derived and general properties of the solutions to the truncated set of equations are discussed. A scheme for solving these equations by Gauss quadratures is given, and, as an example, the solution to the bare infinite cylinder critical problem is given in three orders of approximation. Excellent accuracy is obtained with a fairly small investment of analytical effort. The extension of the method to include the effects of anisotropic scattering is sketched. 24 references. (auth)

2117 ADDITIONAL CONDITIONS TO THE NEUTRON MULTIPLICATION METHOD OF REACTIVITY DETERMINATION. Chwaszczewski, S. (Inst. of Nuclear Research, Swierk, Poland). Nucl. Sci. Eng., 34: 194-7(Nov. 1968).

The external source method for determining the reactivity of a subcritical reactor is discussed from space-energy aspects of neutron diffusion theory. The eigenfunction of the asymptotic rate of neutron flux increase is developed; definitions for neutron generation time and effective delayed neutron yield are applied to obtain an equation for the reactivity. (M.L.S.)

2118 NUMERICAL STUDIES OF COMBINED SPACE–TIME SYNTHESIS. Yasinsky, J. B. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Sci. Eng., 34: 158-68(Nov. 1968).

The ability to obtain accurate solutions to time-dependent group diffusion problems by simultaneously synthesizing in both the z and t dimensions is demonstrated numerically. The potential of the combined space-time synthesis method becomes apparent from several comparisons of synthesis solutions with exact (in a finite difference sense) two-group, two-dimensional, time-dependent diffusion solutions for two different reactor geometries. 16 references. (auth)

2119 TRANSFER FUNCTION FROM REACTOR NOISE. Makino, Akira (Niihama Technical Coll., Japan). Niihama Kogyo Koto Senmon Gakko Kiyo, 3: 29-30(Feb. 1967). (In Japanese).

The mathematical theory for obtaining the reactor transfer function from reactor noise is described. The obvious advantages in this method in comparison with the control rod-oscillator method are described. (NSA of Japan)

2120 NEUTRON WAVE PROPAGATION IN HETEROGENEOUS MULTIPLYING MEDIUM. Hayasaka, Hideo; Takeda, Seiiti (Tohoku Univ., Sendai). J. Nucl. Sci. Technol. (Tokyo), 5: 509-15(Oct. 1968).

Neutron wave propagation is considered by multigroup diffusion theory in a heterogeneous multiplying system having periodic arrays of line fuel rods. The coupled equations are resolved into uncoupled equations by suitable linear transformation. By means of Green functions for a point or a line neutron source, the behavior of the neutron waves originating from a periodically varying neutron source are investigated in an infinite system. In such a system, the neutron fluxes are represented by means of a Floquet solution relevant to the buckling B which depends on the angular frequency ω of the external neutron source. Neutron waves propagate analogously to classic waves spreading in accordance with Hüygens' & Fresnel's principles. (auth)

2121 ELASTIC REMOVAL CROSS SECTIONS OF LIGHT AND MEDIUM ELEMENTS NEAR SODIUM RESONANCE. Tone, Tatsuzo (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 5: 538-41(Oct. 1968).

The elastic removal cross sections of light elements in energies around 3 keV are discussed in order to determine the influence of group boundaries and of different calculation methods on the cross section values. The accuracy of the approximation methods adopted in typical standard sets such as the YOM or the Russian ABN set are examined. Calculations are made for typical large fast reactor compositions. (H.D.R.)

2122 CALCULATION OF THE CRUCIFORM CONTROL ROD WORTH. Makino, Kakuji (Tokyo Shibaura Electric Co., Ltd.). J. Nucl. Sci. Technol. (Tokyo), 5: 516-28(Oct. 1968).

A new method of calculating the worth of cruciform control rods arranged in the D-lattice is presented. The lattice is divided into two regions: a transport region near the control rods, and a diffusion region removed from the rods. The neutron behavior in the former region is treated by collision probability method and in the latter by diffusion approximation. The prompt decay constants calculated are in very good agreement with experimental data, which evidences the accuracy of the method for evaluating cruciform control rod worth. (auth)

2123 STABILITY BOUNDARIES VARIATION DUE TO DELAYED NEUTRON REPRESENTATION IN A GRAPHITE POWER REACTOR. Sastry, V. R.; Deep, G. S. (India Inst. of Tech., Kanpur). J. Inst. Eng. (India), Elec. Eng. Div., 46: 578-90(1966).

The variation of upper and lower limits for the controller gain for the stable operation of a reactor is compared using two mathematical models with delayed neutrons, and with an effective mean neutron lifetime of 70 millisec. and no delayed neutrons. The mathematical model described consists of two active regions; each region is simulated as a point reactor coupled to the other region by neutron diffusion. Two groups of delayed neutrons equivalent to 6 groups of delayed neutrons are assumed in the model. The error signal for the control system is derived from the change in mean fuel temp. The analog computer results indicate that the controller gain at the upper stability boundary is increased by nearly a factor of 5.6 for $a_m = 0$ and 4.6 for $a_m = 16 \times 10^{-5}$ δk per °C when delayed neutron effects are considered. The period of oscillations at this boundary is reduced to about 31 sec. The lower limit for the controller gain and the period of oscillations at this boundary are not significantly affected. Simplifications of the model and their limitations are discussed. The effects of incorporation of xenon variations are also indicated. (Indian Sci. Abstr.)

2124 GENERAL REACTIVITY. Shishin, B. P. At. Energ. (USSR), 25: 327-8(Oct. 1968). (In Russian).

Reactivity and its variations in real nuclear reactors were studied. An attempt was made to resolve the problem of experimental determination of breeding reactor properties which are expressed by reactivity during the transition of reactivity to its equivalent. The equivalent of reactivity was studied as a magnitude equal to the rate of generation of excess neutrons in a reactor described by functions linear to the neutron density. In relation to the reactor breeding characteristics, the new parameter is equal to the reactivity to the order of the difference in their magnitudes. Mathematical formalism was used for determining the abstract reactivity. Formulas were developed for various parameters which, in case of difficulties in determining general reactivity in terms of one form, could be used for determining the corresponding magnitude of reactivity in another form. Such a method generally is used during experimental determination of

ordinary reactivity based on the known measured reactor period. An analysis of experimental determination of general reactivity or its variations showed that the accuracy of determination of respective magnitudes of certain forms of reactivity is higher in comparison to the ordinary reactivity. (R.V.J.)

Experimental Applications

Refer also to abstract 2082.

2125 (CEA-R-3441) MEASUREMENT OF FLUX INTENSITY AND EPITHERMAL FLUENCE IN THE NEIGHBOURHOOD OF 1 keV (TWO P–Cu DETECTOR METHOD). Farny, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1968. 34p. (In French). Dep.

The measurement of epithermal intensity in the 0.5 to a few tens of eV using conventional resonating detectors: Pu, Lu, In, Au, etc..., is carried out in an energy range which is of little interest from the point of view of radiation damage studies. It is for this reason that we have attempted to measure the flux per unit of lethargy in the region of one keV independently of any consideration concerning the shape of the spectrum, as long as it is declining. This method can be summarized as a subtraction: from the total activity of a detector resonating at one keV (copper) is subtracted the activity which does not correspond to its resonances using a second detector whose cross-section is in 1/v (phosphous). By using B_4C as screen it is possible to have a cut-off at about 100 eV and thus improve the accuracy. A calibration using cobalt allows a direct measurement of the epithermal flux in the keV region. (auth)

2126 (K-DP-2961) ADJOINT BIASING IN MONTE CARLO CRITICALITY CALCULATIONS. Whitesides, G. E. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). [1967]. Contract W-7405-eng-26. 6p. (CONF-680601-35). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

As interest grows in using Monte Carlo techniques in determining criticality conditions of reactor systems, a technique must be used to minimize the amount of computer time spent following thermal neutrons for large numbers of collisions in low importance regions. A technique is described which yields a minimum variance per unit computer time for a number of systems with thick reflectors. (auth)

2127 (RF/FI-(68)27) KINETICS OF TWO LOOSELY COUPLED MULTIPLYING SYSTEMS. Farinelli, U.; Pacilio, N. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 63p. (In Italian). Dep.

Pulsed measurements were made in two organic moderated and reflected loosely coupled cores in order to analyze their kinetic and reactive behavior. Under the hypothesis of loose coupling, the time analysis of the pulse response of the reactor gives separate information on the component core reactivity, on the coupling amount, and on the neutron lifetime. Values exist which are strictly correlated to these quantities: they characterize the neutron decay in any point of the system. (auth)

2128 (RT/FI-(68)23) DETERMINATION OF THE REACTIVITY FOR A SAMPLE OF FINITE DIMENSIONS INTRODUCED INTO THE REACTOR. Orestano, F.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1968. 37p. (In Italian). Dep.

The reactivity of non-moderating samples introduced in RANA reactor for oscillating measurements of effective absorption cross sections is evaluated. The evaluation is made by a two dimensional calculation method in transport theory properly devised for the present problem, but also interesting for other more general situations. (auth)

2129 (WAPD-T-2111) CALORIMETRIC RADIATION HEATING RATE MEASUREMENTS IN A CRITICAL ASSEMBLY AND COMPARISON TO DIFFUSION THEORY CALCULATIONS. Mikoleit, L. A.; Braun, J. C.; Beyer, R. F.; Ryan, T. M.; Valentine, R. F. (Bettis Atomic Power Lab., Pittsburgh, Pa.). May 1968. Contract AT(11-1)-Gen-14. 14p. (CONF-680601-43). Dep. CFSTI.

From 14th Annual Meeting of the American Nuclear Society, Toronto, Ontario.

Calorimetric radiation heating rates were measured with various non-fuel materials in a very low power critical assembly. Detailed neutron and gamma ray distributions throughout the assembly and the absolute power level were also determined, thus providing a comprehensive set of data to test design models for calculating in-core radiation heating rates. One set of detailed diffusion theory calculations was completed and the results compared with experiment. Described are the calorimetric measurements, the diffusion theory calculations, and the comparison of the two. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 351, 365, 593, 721, 746, 978, 1019, 1024, 1035, 1050, 1059, 1752, 1759, 1769, and 1775.

2130 (BNWL-SA-2065) RESULTS FROM USAEC PLUTONIUM UTILIZATION PROGRAMS CONDUCTED BY BATTELLE-NORTHWEST. Dawson, F. G. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 28, 1968. Contract AT(45-1)-1830. 101p. (CONF-680924-1). Dep. CFSTI.

From Panel on Plutonium Utilization, Vienna, Austria.

A status report on the present technology of Pu is presented. Topics discussed include: Pu utilization; fuel characteristics of Pu; fuel fabrication; physics behavior; and Pu fueling in water reactors. (D.C.C.)

2131 (EUR-4033) IN-PILE THERMAL EXPANSION OF URANIUM DIOXIDE TENTATIVE SYNTHESIS. Marchandise, H. (European Atomic Energy Community). Apr. 26, 1968. 62p. (In French). Dep.

A tentative synthesis of the published data on the in-pile thermal expansion behavior of UO_2 in sintered pellet shapes is presented. (auth)

2132 (NP-17579, pp V.3-7) REACTOR STUDIES AND MATHEMATICS. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)).

Theoretical models, calculation codes, programming languages, and computer devices for reactor studies are described. (auth)

2133 (ORNL-TM-2332) PARTIAL INVESTIGATION OF FUEL CHANNEL SPACERS FOR AN HFIR-TYPE FUEL ELEMENT. Cheverton, R. D.; Kelley, W. H. (Oak Ridge National Lab., Tenn.). Aug. 13, 1968. Contract W-7405-eng-26. 25p. Dep. CFSTI.

A partial investigation has been conducted in connection with the use of coolant channel spacers in an HFIR-type fuel element. Heat transfer studies indicate that Al, wire-type, opposed spacers will reduce the burnout heat flux by only 6%. Fabrication development indicates that the wire spacers could be either welded to the plates with an ultrasonic welding technique, or they could be drawn into the channels of an otherwise assembled element and welded at the ends only. Flow tests on both types, using a 9-plate-segment test element, resulted in no fretting corrosion or other deleterious mechanical effects. (auth)

2134 (ORNL-tr-1830) EXPERIMENTAL STUDY OF THE FABRICATION OF PLATE FUEL ELEMENTS CONTAINING A CERMET CORE. Capocchi, Jose Deodoro Trani; Cintra, Sebastiao Hermano Leite; Gentile, Erberto Francisco. Translated for Oak Ridge National Lab., Tenn., from Metalurgia (Sao Paulo), 24: 201-12(Mar. 1968). 22p. Dep. CFSTI.

Fabrication procedures are described for reactor fuel element plates containing cores of Al–U_3O_8 dispersions with 55 to 75% concentrations of U_3O_8. The production of the cermet by powder metallurgy, the fabrication of the Al alloy-clad plates by rolling, and the quality control tests are presented. (H.D.R.)

2135 (WAPD-TM-770) INELASTIC BOWING OF MULTISPAN FUEL RODS SUBJECTED TO AXIAL THRUST AND TEMPERATURE GRADIENTS (LWBR DEVELOPMENT PROGRAM). Newman, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1968. Contract AT-11-1-GEN-14. 102p. Dep. CFSTI.

Bowing of multispan rod-type fuel elements depends upon heat-generation gradients, variations in heat transfer processes, and axial thrust. The fundamental aspects of the analysis of axially compressed multispan inelastic beams are presented. Flexibility of supports in both axial and transverse directions is considered and the method is applicable to problems in which the thrust depends upon the transverse deflection as well as problems involving prescribed axial thrust. The formulas presented here constitute the theory for a computer program of broad applicability in the transient analysis of fuel rod bowing. (auth)

2136 GRAPHICAL ANALYSIS OF REACTOR BREAKDOWNS. Knecht, Othmar; Keil, Horst (Internationale Atomreaktorbau GmbH, Bensberg, Ger.). At. Strom., 14: 107-10(July-Aug. 1968). (In German).

A graphical method by means of which complicated reactor breakdowns can be analyzed in a clear and simple manner is described. Dynamic and logical symbols are introduced for the

purpose. The diagrams are quantified by giving failure rates for individual constructional components. This means that the effects of breakdowns can be described by two quantities: by their probability and by their extent. The risk of breakdown in an installation, composed of these two quantities, can be expressed as a figure. (auth)

2137 TRANSIENT TEMPERATURE DISTRIBUTION IN A REACTOR CHANNEL WITH CYLINDRICAL FUEL RODS AND COMPRESSIBLE COOLANT. Vollmer, Heinz (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Sci. Eng., 34: 148-57 (Nov. 1968).

Local and weighted transient temperatures in a cylindrical, cladded fuel rod and a single-phase compressible coolant are determined by a linear analytical model applying Laplace transformation. All independent variables determining the channel temperatures and the interaction between fuel, canning, and coolant temperatures are taken into account. Assuming constant material properties in the fuel rod, the calculation of fuel and clad temperature is shown to require four functions defined such that one argument is real and depends on geometry only. Material properties affect only the other (imaginary) argument, and different properties result in parallel displacement of the functions. These features enable a relative general presentation of the functions for various geometries and material properties. The functions determining coolant temperature may be given in an integral-free form if, essentially, the can-to-coolant heat transfer coefficient is space independent. The model was originally developed for use in steam cooled fast reactor analysis. It may be applied to other fast or thermal systems with single-phase coolants. Furthermore, it may serve as a means for evaluating numerical approximations of nonanalytical finite difference methods (e.g., to establish the necessary number of subregions). (auth)

2138 NUCLEAR FUEL AND BLANKET ELEMENTS. Sermon, G. T. (to Ultra Carbon Corp.). Canadian Patent 785,696. May 21, 1968.

Manufacturing details are described for producing elements which are resistant to thermal stresses, creep and uneven shrinkage and retain their original shape even after prolonged use at high temperature. The raw materials are coal tar pitch, graphite having a low B content, along with fertile and fissionable materials. An essential feature is a graphitization temperature in excess of 2000°C so that the fuel materials are converted to carbides. Uniform dispersion and a firm bond are attained in process. (F.S.A.)

2139 HEAT EXCHANGER USEFUL IN NUCLEAR REACTOR SYSTEM. Worley, Norman G.; Taylor, Anthony J.; Prasher, Charles L. (to Babcock and Wilcox Ltd.). U. S. Patent 3,393,664. July 23, 1968. Priority date Nov. 25, 1963, Great Britain.

A steam generator and superheating plant for a nuclear reactor are described. The forced flow boiler consists of serially connected steam and superheat sections of multiple variable-length pipes. A controlled flow of liquid coolant runs parallel to the steam inlet and has an intermediate connection in the steam generator. (Offic. Gaz.)

2140 STRESS ANALYSIS FOR DRYWELL OF REACTOR PRIMARY CONTAINMENT VESSEL. Hamada, Kunio; Hayashi, Tsutomu (Hitachi Ltd., Tokyo). Hitachi Hyoron, 50: No. 6, 13-17(June 1968). (In Japanese).

The drywell of a reactor containment vessel is of a symmetrical shape, produced by rotating it with the axis as the central line; and an axis-symmetrical load is applied to it. The configuration and the load are both complicated, and the stress analysis by ordinary methods is very difficult. A procedure whereby the basic differential equations are solved speedily by an electronic computer, and the results of analysis are described. By this method, the complicated distribution of stresses can be obtained accurately—leading to the estimate of stresses as required in ASME Section III and to the highly reliable design of a containment vessel. (NSA of Japan)

2141 PROCESS FOR REMOVING RADIOACTIVE MATERIALS FROM THE ENVIRONMENT OF AN ATOMIC REACTOR. Rendos, John J. (to Air Reduction Co., Inc.). U. S. Patent 3,404,067. Oct. 1, 1968. Filed Feb. 12, 1965.

In combination with a nuclear reactor comprising a core contained in a pressure vessel surrounded by shielding means forming a chamber, an environmental control system is described. Air is forced into the chamber during normal operation of the reactor to remove radioactive contaminants. The air is directed to the atmosphere after its exhaust from the chamber. Detecting means sense the concentrations of radioactive contaminants in the air. A closed conduit system introduces an inert gas into the chamber to remove the contaminants from the chamber, the detecting means triggering the system for introducing inert gas when a predetermined level of contaminants has been sensed by the detecting means. The system removes the contaminants from the inert gas. (Offic. Gaz.)

2142 JET PUMPING SYSTEM FOR A NUCLEAR REACTOR. Howard, Charles L. (to General Electric Co.). U. S. Patent 3,400,047. Sept. 3, 1968. Filed Feb. 21, 1967.

An improved jet pump capable of controllable reverse flow for controlling the coolant flow in a reactor vessel through the nuclear reactor core is described. The pump body is provided with at least one auxiliary driving fluid jet adapted to permit a controllable flow through the pump in the reverse direction from normal flow. (Offic. Gaz.)

2143 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Sulzer Brothers Ltd.). British Patent 1,132,207. Oct. 30, 1968. Priority date Nov. 16, 1964, Switzerland.

A control system for a nuclear reactor is described which relies on a control signal which is obtained by combining a neutron flux signal with a heat output signal. The control signal is then compared with the heat output signal and the resultant difference signal is used to regulate the reactor reactivity. A second difference signal is obtained by comparing the resultant difference signal with a limiting-value signal. The second difference signal is used to regulate a rapid shut-down system. (D.C.C.)

2144 NUCLEAR REACTORS. Godfrey, Alan; Martin, Dudley James Victor; Lewis, Robert Alec (to United Kingdom Atomic Energy Authority). British Patent 1,131,307. Oct. 23, 1968. Filed Sept. 7, 1965.

A reactor is described which consists of multiple pressure tubes penetrating and moderator mass. Each sealed pressure tube contains a fuel assembly and operating fluid coolant. A central tube penetrates the pressure tube and contains multiple side apertures to provide emergency spray cooling when needed. (D.C.C.)

2145 REACTOR FLUX MEASURING SYSTEM WITH COUNTER OUTSIDE CORE. Spooner, John Brett (to English Electric Co., Ltd.). British Patent 1,132,357. Oct. 30, 1968. Filed Oct. 15, 1965.

A neutron flux measuring system for a nuclear reactor is presented. The system is used with reactors with multiple fuel channels. The system consists of multiple closed-circuit sample pipes adjacent and parallel the fuel channels which circulate an oxygen-containing fluid. Gamma radiation emission from the fluid is measured outside the core. A scintillation counter is used for the measurements. Multi-inlet selector valves control which sample tubes are used for the neutron flux measurements. (D.C.C.)

2146 NUCLEAR REACTOR FUEL ELEMENTS. Redford, Derek Stanley; Tilbe, Horace Edgar (to United Kingdom Atomic Energy Authority). British Patent 1,132,356. Oct. 30, 1968. Filed Sept. 9, 1965.

A method of closing an end of a protective tube for pin-type fuel elements is described. An electromagnetically generated shock wave serves to form an aperture in the neck to secure the plug which is then sealed by welding. (D.C.C.)

2147 AN ORIGINAL SOLUTION: THE HOT-WALL VESSEL. Courbon, J.; Merot, J. P. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), No. 70, 32-8(May-June 1968). (In French).

The concept of treating a prestressed concrete pressure vessel as a heat pipe for heat transfer analyses is presented. Operating conditions for a boiling heavy water reactor pressure vessel are given. Experimental investigations on temperature behavior, relaxation, and thermal conductivity of prestressed concrete pressure vessels are summarized; results of studies on 17-4 PH steel and Type 18/10 stainless steel for pressure vessel liners are outlined. (M.L.S.)

2148 MECHANISM FOR CONTROLLING RECIPROCATION OF TWO RODS CONNECTED BY GEARING. (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,131,652. Oct. 23, 1968. Priority date May 28, 1965, Germany.

A description of a nuclear reactor reciprocating control rod geared drive system is presented. The control rod consists of two parallel rods with vertical guides. The driving gear is a pinion and is located between the two rods to produce reciprocal motion in the rods. Movable slides perpendicular to the rods move in opposite directions to provide locking means to retain the rods as they are disengaged. (D.C.C.)

2149 AN ON-LINE AUTO- AND CROSS-CORRELATOR FOR NUCLEAR REACTOR NOISE ANALYSIS. Sides, William Hutton Jr. Raleigh, N. C., North Carolina State Univ., 1968. 180p. Thesis.

An on-line digital auto- and cross-correlator is designed and tested as part of a project which has as its purpose the investigation of the sensitivity of boiling detection methods for nuclear reactors. The correlator is designed to produce the auto- and cross-

correlation functions of low frequency signals, i.e., in the range of from 0.05 Hz to 55 Hz. Digital methods are employed to perform the required multiplications and integrations. Tests of the instrument indicate excellent low frequency response and resolution for both auto- and cross-correlation computations. Auto- and cross-correlations of the neutron flux noise on the North Carolina State University Reactor 3 (NCSUR-3) are obtained. (Disser. Abstr.)

2150 FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTORS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,131,573. Oct. 23, 1968. Priority date Jan. 11, 1966, Germany.

A description of a nuclear reactor fuel element assembly is presented. The assembly consists of multiple rod-shaped fuel elements arranged in a bundle. Each fuel element has three longitudinal helical fins. The fuel elements are arranged in a hexagon-shaped bundle so that the fins cross each other at multiple points. The fuel bundle is surrounded by other fuel elements with three straight fins parallel to the longitudinal axis. A center three-finned fuel element is also included. (D.C.C.)

2151 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTORS. Ziegler, A. (to Siemens-Schuckertwerke, AG). Canadian Patent 784,824. May 7, 1968. Priority date Mar. 6, 1964, Germany.

Prefabricated concrete segments are spaced circumferentially with gaps between them filled with "pressure-resistant material" so as to form a hollow concrete cylinder open at both ends. Annular prestressing means surround this hollow cylinder. The open ends are closed with concrete blocks held in place with large bolts with the entire assembly designed to resist strong outward pressure which may be exerted on the inside during reactor operation. (F.S.A.)

GENERAL

2152 (AEC-tr-6816) NUKLEONIKA. Translation of Nukleonika, 12: 459-588(1967). 125p. (AEC-tr-6817). CFSTI.

Ten articles were previously abstracted from the original language and appeared in NSA as 22: 2183, 2186, 2369, 2416, 2443, 2472, 3581, 3593, 6730, and 8556. (C.E.S.)

2153 (BNWL-878) SIMPL-1: SIMULATION IMPLEMENTING MACHINE PROGRAMMING LANGUAGE-VERSION 1. Benham, R. D. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1968. Contract AT(45-1)-1830. 87p. Dep. CFSTI.

SIMPL-1 is a hybrid operating software system for a fixed point PDP-7 digital computer and a Beckman 2133 analog computer. The programming method associated with SIMPL-1 belongs to the same family of continuous simulation language as MIDAS and PACTOLUS. The method is a dialect of the Digital Equipment Corporation's PDP-7 assembly language. When used on our most sophisticated nuclear plant simulation the hybrid processes information about 400 times faster than more conventional programming methods employing a UNIVAC 1108 digital computer equipped with floating point hardware. When SIMPL-1 programming methods are used without including the analog computer as part of the system, the effective speed of the system is decreased. However, the SIMPL-1 programming method increases the effective computing speed by factors up to 1000 as compared to software floating point FORTRAN. The computing frame time for this simulation is approximately 20 msec, which corresponds to processing speeds 10 times faster than real time. (auth)

2154 (COO-1018-1132) QUARTERLY TECHNICAL PROGRESS REPORT, JULY-SEPTEMBER 1967. (Illinois Univ., Urbana. Dept. of Computer Science). 254p. (COO-1469-73). Dep. CFSTI.

The circuit research program, hardware and software systems research, Illinois pattern recognition computer: ILLIAC II, ILLIAC IV, numerical methods, computer arithmetic, and artificial languages, computational physics, switching theory and logical designs, ILLIAC II and IBM 7094/1401 service, uses, and program development, problem specifications, and general laboratory information are discussed. (W.H.K.)

2155 (IS-1900) CERAMIC AND MECHANICAL ENGINEERING, CHEMICAL ENGINEERING, CHEMISTRY, MATHEMATICS AND COMPUTER SCIENCE, METALLURGY, PHYSICS, AND REACTOR DIVISIONS ANNUAL SUMMARY RESEARCH REPORT, JULY 1, 1967-JUNE 30, 1968. (Ames Lab., Iowa). July 1968. Contract W-7405-eng-82. 442p. Dep. CFSTI.

Individual abstracts were prepared for the research summaries of each of the 7 Ames Laboratory divisions. (H.D.R.)

For abstracts of individual sections see: 213, 345, 962, 1020, 1580, 2066, and 2156.

2156 (IS-1900, Paper 4) MATHEMATICS AND COMPUTER SCIENCE DIVISION. Spedding, F. H.; Maple, C. G.; Carlson, B. C.; Lambert, R. J.; Stewart, R. M. Jr. (Ames Lab., Iowa). 12p.

Research and development are summarized on Ames Research Reactor real time computer control, computerized control of isotope separator, programming systems, and computerized information systems. Research progress on mathematics is also summarized. (J.R.D.)

2157 (LA-DC-9384) ENERGY REQUIREMENTS FOR MITOSIS IN CHINESE HAMSTER CELLS. Tobey, R. A.; Petersen, D. F.; Anderson, E. C. (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 31p. Dep. CFSTI.

Cultures of detached Chinese hamster cells were added to spinner flasks for assessing the effects of inhibitors on mitosis. Graphs are presented to show the inhibitory effects of antimycin A on the cells. Similar results were obtained with rotenone, oligomycin, and 2,4-dinitrophenol. Results indicated that under conditions of inhibition of respiration or phosphorylation most of the metaphase cells were unable to complete mitosis. Results also indicated that cells in anaphase or telophase were essentially insensitive to the effects of inhibitors. Methods of determining the location of a temporal marker within mitosis are described. A culture of HeLa cells in mitosis was treated with rotenone; results indicated that mitosis was stopped several minutes before the metaphase/anaphase boundary. It is pointed out that the precise location of the temporal marker in relation to the phases of mitosis is dependent upon the time required for entry of inhibitors into the cell. Results are discussed in relation to the process of energy production during the entire mitotic period. (H.L.W.)

2158 (LA-DC-9569) LIQUEFIED HYDROGEN SAFETY. A Review. Edeskuty, F. J.; Reider, Roy (Los Alamos Scientific Lab., N. Mex.). [1968]. Contract W-7405-eng-36. 12p. (CONF-681102-1). Dep. CFSTI.

10th Liquid Propulsion Symposium, Las Vegas, Nev.

The accident experience and accident potential in the use of liquefied hydrogen is examined with respect to cold damage to tissue, asphyxiation, hydrogen/air (O_2) mixtures, material properties, air and moisture condensation and pressure buildup. The control of liquefied hydrogen safety problems is reviewed in: facility design which includes site selection, materials of construction, hydrogen, disposal, pressure relief (storage, insulation space, and experimental volumes) and control of spills; safe procedures which include standard operating procedures, safety training and education, emergency procedures, control of ignition sources; and operating principles such as hydrogen monitoring, storage above atmospheric pressure, purging (before and after operations), inerting, leak control, chilldown procedures, venting procedures. (auth)

2159 (MLM-1557) STATISTICAL EVALUATION OF A GAS PRESSURE-VOLUME-TEMPERATURE MEASUREMENT SYSTEM. Bohl, D. R.; Sellers, D. E. (Mound Lab., Miamisburg, Ohio). Oct. 11, 1968. Contract AT-33-1-GEN-53. 18p. Dep. CFSTI.

A data evaluation study was conducted to statistically evaluate a gas pressure-volume-temperature system for measuring the amount of gas evolved from a thermally decomposed sample. The standard deviation and confidence intervals were calculated using historical data from the gas measurement analytical procedure. Conventional statistical formulas were used to evaluate the data. (auth)

2160 (NYO-3354-3) DNA, RNA, AND PROTEIN STUDIES IN CHLOROPLASTS OF ACETABULARIA. Final Progress Report. Schreiber, Richard W. (New Hampshire Univ., Durham). [1968]. Contract AT(30-1)-3354. 10p. Dep.

Technical difficulties with Acetabularia made it necessary to use tobacco seedlings as the experimental material for these studies. The ultrastructure, pigment-retention capacities, and metabolism of chloroplasts maintained in association with aerobic bacteria were examined. A detailed comparison was made of acetate, CO_2 and ^{14}C-leucine incorporation into a chloroplast-specific lipoprotein complex of in vivo and sterile in vitro chloroplasts. An electron microscope analysis was made of Cyanophora paradoxa, a flagellated cryptomonad containing a blue-green endosymbiont. This organism is of particular interest since it may represent an early stage in the evolution of chloroplasts from blue-green symbionts. Attempts are being made to establish structural and biochemical differences between an evolving blue-green endosymbiont and the modern chloroplast. (H.L.W.)

2161 (SC-TM-68-587) TRACE METAL ANALYSIS IN WATER BY ATOMIC ABSORPTION SPECTROPHOTOMETRY. Grillo, J. P. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1968. 30p. CFSTI.

The analysis by atomic absorption spectroscopy of Cd, Cr, Cu, Fe, Mn, Pb, and Zn in water is discussed, particularly in the concentration range of concern to water pollution chemists. Of particular interest is the discussion of the limit of sensitivity for these seven elements in the parts-per-billion concentration range. The direct aspiration of the water sample into the atomic absorption flame for analysis of the metals studied seems to warrant further work toward acceptance as a standard method for trace metal contaminant analysis. (auth)

2162 (TID-24123) EXPERIMENTALLY ORIENTED SCIENCE EXHIBITS. Designed and Constructed by Lawrence Hall of Science. Jackman, Kenneth (California Univ., Berkeley). Oct. 1968. Contracts 68-05-63; AT(04-3)-332. 54p. CFSTI.

Fifteen science exhibits already completed as presently under construction at the Lawrence Hall of Science are briefly discussed. These include gamma absorption, differential gamma absorption, backscattering, random counting, inverse-square law, half-life of silver, linear accelerator, mechanical cyclotron, hidden-target pinball machine, Rutherford scattering, Rutherford thick-target machine, periodic table, calcium intake, chromatography, and dice-game probabilities. (B.G.D.)

2163 (TID-24747) QUARTERLY TECHNICAL PROGRESS REPORT, OCTOBER-DECEMBER 1967. (Illinois Univ., Urbana. Dept. of Computer Science). 266p. Dep. CFSTI.

The circuit research program, hardware and software systems research, the Illinois pattern recognition computer ILLIAC II,

ILLIAC IV, numerical methods, computer arithmetic, and artificial languages, computational physics, and switching theory and logical designs are discussed. Also, the service, uses, and program development of ILLIAC II and IBM 7094/1401, problem specifications, and general laboratory information are reported. (W.H.K.)

2164 (UCRL-50451) IMPROVING AVAILABILITY AND READINESS OF FIELD EQUIPMENT THROUGH PERIODIC INSPECTION. Epstein, Benjamin; Schiff, Albert (California Univ., Livermore. Lawrence Radiation Lab.). July 16, 1968. Contract W-7405-eng-48. 14p. Dep. CFSTI.

In improving availability and readiness of field equipment, field operation of equipment is viewed as a continuing process with periodic checks and calibrations to discover failed items which are restored to operation. Expressions are derived to determine long-run availability or readiness of items of equipment and the number of units which must be in the field in order that a minimum number of items are available at anytime. The expressions which are derived are independent of the number of systems in operation. (F.S.)

2165 (UCRL-50464) PREPARATION AND PROPERTIES OF 2,2-DIFLUORO-2-NITROETHYL ACRYLATE POLYMERS. Bissell, Eugene R. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 1, 1968. Contract W-7405-eng-48. 9p. Dep. CFSTI.

Various 2,2-difluoro-2-nitroethyl acrylate polymers and copolymers were prepared and their properties observed in an effort to find a polymer best suited for making extrusion case explosives and binders for explosives. Plasticizers significantly lowered the glass transition temperature of the homopolymer, but copolymerization had much less effect. Most cross-linking agents greatly improved the mechanical properties of the polymers without significantly altering their glass transition temperature. (auth)

2166 (UCRL-50479) APPARATUS FOR PRODUCING MACHINABILITY TEST SPECIMENS FOR STUDIES OF HIGH-SPEED CHIP FORMATION ON AN ENGINE LATHE. Gordon, Carroll (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 15, 1968. 15p. Dep. CFSTI.

LRL Mechanical Shops Department has developed a safe and effective method for preparing metallurgical test specimens for the study of chip formations on metals, using single-point tools. This equipment, using a drop-hammer technique, drives the cutting tool from the workpiece, leaving the nascent chip attached to the parent metal. This chip is then segmented out of the test piece and processed metallographically. Photographic studies of the tool removal process show that the cutting tool is removed from a 300-ft per min. cut in approximately 1 μsec. (auth)

2167 AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED KINGDOM OF GREAT BRITAIN AND NORTHERN IRELAND AND THE GOVERNMENT OF THE REPUBLIC OF FINLAND FOR CO-OPERATION IN THE PEACEFUL USES OF ATOMIC ENERGY, WITH EXCHANGE OF NOTES. Helsinki, 24th May 1968. Cmnd. 3761 (Atomic Energy) (Finland No. 1, 1968). London, Her Majesty's Stationery Office, 1968. 10p. 1s. 9d.

2168 UNITED KINGDOM ATOMIC ENERGY AUTHORITY, 14th ANNUAL REPORT AND ACCOUNTS, 1967-68. London, Her Majesty's Stationery Office, 1968. 125p. 13s.

The report covers the period from 1st April 1967 to 31st March 1968. Section headings are as follows: General survey; finance, accounts and contracts; trading fund report; production factories and the Radiochemical Centre, Amersham; the reactor program; nuclear research and development program; non-nuclear research and development; health and safety; international relations; information services; staff. Appendixes include: Membership of Atomic Energy Authority; senior staff; Authority reactors as of 31st March 1968; comparison of 1967/68 grant and 1968/69 estimates under the atomic energy vote; list and functions of Authority establishments; summary of recommendations of Select Committee on Science and Technology; nuclear power industry. The balance sheet as at 31st March 1968, and accounts for the year ended 31st March 1968, and the report of the Comptroller and Auditor General are included. An illustrated summary of the 14th Annual Report, entitled Atom 68, is published separately. (UK)

2169 EXPANSION OF EXPERIMENTAL FUNCTIONS IN SERIES OF DESCENDING EXPONENTIALS OF REAL ARGUMENT. Servais, Fr. J. (Belgo Nucleaire, Brussels). Nucl. Sci. Eng., 34: 196-7(Nov. 1968).

It is shown that the amplitudes and decay constants obtained by the expansion of experimental functions in series of descending exponentials with real arguments are unstable. (J.W.R.)